SANITATION MANUAL.

Preliminary Draft of

A SANITATION MANUAL FOR FOOD INDUSTRIES

A Class Project

Special Training Course in Plant Sanitation

School of Public Health, University of California

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FOREWORD

One of the primary responsibilities of the School of Public Health of the University of California is to provide training courses designed to meet the needs in the field of environmental sanitation. Accordingly, at the request of the National Canners Association, a special training course for plant sanitarians was organized, designed to assist their membership in promoting a modern sanitation program.

In the development of the eight weeks' curriculum for the Special Training Course in Plant Sanitation, provision was made for the development of a sanitation manual. Because of the shortness of time and the heavy daily schedule, it was foreseen that only an elementary approach could be expected. However, it proved to be an excellent class exercise, obliging the students to digest the fundamentals of sanitation and to apply them in a practical manner.

The need of a manual was discussed in class and a committee was elected to work over the chapter outlines and subheadings. The proposed outline was again discussed; then two students were assigned to the preparation and presentation of each chapter. An essay form of presentation was preferred, but certain groups believed that their subjects could be presented best in outline, and this was permitted. During the final week, the progress of the manual stimulated much discussion, which resulted in numerous revisions before the papers were finally submitted.

It is hoped that this limited class project will instigate further study and result in the drafting of a finished manual.

Walter S. Mangold

Attention is directed to the authority of the Bureau of Food and Drug Inspection, California State Department of Public Health, over all food-processing plants operating within the State of California. Statutes and regulations govern all phases of food-plant sanitation as well as other standards applying to the production of processed foods.

CONTENTS

Chapter I

INTRODUCTION

Recognition has long been given to the principle that the public is entitled to protection from illness and death caused by consumption of impure foods. Initial regulatory efforts were directed mainly toward protection of food from contamination with pathogenic organisms or with other substances harmful to the health of the consumer. There also has developed a public consciousness, reflected by regulatory agencies, that in addition to protection of his health the consumer has the right to protection against practices violating hygienic decency—practices which are offenses only to his aesthetic sense.

This conception of sanitary practice was incorporated in the Federal Food, Drug, and Cosmetic Act of 1938 which specifically states that "a food shall be deemed to be adulterated if it consists in whole or in part of any filthy, putrid or decomposed substance or if it is otherwise unfit for food—or if it has been prepared, packed or held under insanitary conditions whereby it may have become contaminated with filth." A cursory inspection of recent actions taken by the Food and Drug Administration under the Act will reveal that offenses against hygienic decency are cited in the libels in more than half the cases. In addition to avoiding conflict with the law, modern sanitary practices return considerable dividends in the long run through (1) improved quality and lower spoilage of the product, (2) better consumer acceptance, (3) less loss of time from accidents and from breakdown of equipment, and (4) greatly improved employee morale—decidedly important under present labor conditions.

Some states have legislated for the regulation of canneries and are staffed to give inspectional services in this field. One of the early laws was Chapter 428, California Statutes of 1925: "An act to regulate the conduct of canneries, to create a Division of Cannery Inspection to carry on such regulations, to provide rules regulating the proper sanitation of canneries under the State Board of Health." This Act, as amended to 1945 inclusive, reads in part:

Sec. 9. The State Board of Public Health may after notice and opportunity for hearing for the following cause or causes suspend or revoke a license issued under this act:

(a) The nonpayment of said pro rata share of the cost, or failure to comply with a demand for a cash deposit or other security by the holder of such license.

(b) The noncompliance with any of the regulations of the State Board of Public Health.

(c) After conviction for violation of the California Pure Foods Act (Health and Safety Code) the license may be suspended for a period of from one to 30 days.

(d) The operation of an insanitary cannery after due notice by registered mail has been received.

(e) Inadequate rat-proofing of a cannery throughout.

(f) Wilful packing of any canned food commodity which has been rejected by a duly authorized agent of the State Department of Public Health.

(g) The packing of any food commodity under the supervision of this act without notifying the State Department of Public Health before packing same.

The California Health and Safety Code as amended by Stats. 1939, Ch. 731, and by Stats. 1941, Ch. 1149, reads in part:

26470. A food shall be deemed adulterated: . . . (4) If it has been produced, prepared, packed or held under insanitary conditions whereby it may have become contaminated with filth, or whereby it may have been rendered diseased, unwholesome or injurious to health; . . .

Thus a new significance has been given to the sanitation of foods, and food processors can no longer be concerned only with obvious grossly insanitary conditions.

The responsibility for sanitary control should be placed in the hands of qualified sanitarians who are given the authority and coöperation which this phase of production deserves, just as quality control in most food-processing plants has been placed under the charge of trained personnel responsible directly to the management. The Food Industry Sanitarian, like the Quality Control Supervisor, and like the Public Health Sanitarian, must function in both regulatory and advisory capacities to insure that the product under his supervision meets all the requirements of hygienic decency. The Food Industry Sanitarian need not be a fully trained technologist, bacteriologist, entomologist, parasitologist, or sanitary engineer, but it is necessary that he combine the viewpoints of these professions in the performance of his duties. In the performance of his work the sanitarian frequently will touch upon matters under the jurisdiction of other technical personnel in the plant. For example, one of the outstanding sources of contamination in the finished product is raw stock infested before arrival at the plant. Although the sanitarian is vitally concerned with this matter, in most plants the direct supervision of the character of the raw material is placed in the hands of either the quality control department or the agricultural department. Clearly, a definition of each man's responsibility is necessary.

Duties included in the function of Food Industry Sanitarian are, in general, the following:

1. Supervision of the fresh-water supply.
2. Maintenance of adequate clean-up procedures to prevent utilization of unclean equipment.
3. Control of rodents, insects, and other vermin within the plant.
4. Supervision of matters of personal hygiene.
5. Consultation in planning new, or altering old, equipment or buildings.
6. Supervision of sewage and waste-disposal systems.
7. Supervision of sanitation and health problems resulting from operation of company-owned eating establishments or housing units.
8. Regulation of sanitary facilities within the plant: toilets, restrooms, dressing rooms, etc.
9. Planned maintenance of general tidiness or housekeeping of the plant and premises.
10. Supervision of sanitary warehousing of raw ingredients and finished products.
11. Supervision of lighting, heating, and ventilation of the plant so far as these factors relate specifically to maintenance of sanitary concepts.

The purpose of this manual is to present certain general principles and to call attention to various kinds of materials and methods which are available in effecting proper sanitary control. Detailed direction for handling the many specific problems of food-processing plants cannot be included, of course, but a list of references which present these matters in greater detail is appended.

Chapter II

RODENTS AND INSECTS

RODENTS

I. Reasons for Combating

A. Rodents destroy food, damage wood, paper, and construction materials. They cause more damage than fire and hurricane combined.
B. Rodents carry diseases, a few of which are: typhus, plague, *Salmonella* infection.
C. Rodents are spread by commerce and go anywhere man goes. The presence of rodents in food plants indicates poor housekeeping and poor management. Rodent contamination easily finds its way into the product.

II. Varieties Usually Encountered, and Habits

A. *Norway rat.*—Gray-brown, 16 in. over-all length, 1–1½ lb. Most important rodent, seldom above ground-floor levels, found in lowland areas, residences, farms, warehouses, garbage dumps, sewers, etc. Lives close to man, fond of water, good swimmer.
B. *Black rat.*—Black.
C. *Roof rat.*—Gray-brown. These latter two rodents primarily inhabit upper areas of buildings except when Norway rat is absent; average over-all length 15 in., seldom over ½ lb., climb readily, extremely agile.

Rats are sly, nocturnal, seldom seen in open spaces, prefer to move along walls, piping, or behind or underneath other objects. Rat becomes adult in 4 months; continues growth until 18 months; has a life span of 3–5 years; and may breed in all seasons. Gestation period is 21–25 days. Female may produce 3–12 litters annually, average 3–6. Number of young per litter varies from 6–22, average 10. Food supply, age, climate, condition of female are controlling factors.

D. *House mouse.*—1 oz. weight, 7 in. over-all length. Mice mature in three months, gestate in 19–21 days. Many litters can be produced in a year; 2–9 young per litter, average 5–6.

E. *Squirrels, gophers, moles,* and other miscellaneous wild rodents sometimes cause damage to agricultural areas. Compared with rats and mice, they are not as important in extent of habitat and amount of damage, and they are not prone to live in close proximity to man.

III. Problems Involved in the Elimination of Rodent Infestations

A. Causes of infestations within a plant

1. Accessible food. This results from (*a*) poor storage of raw products, (*b*) improper cleaning of equipment, (*c*) laxity in general cleaning of plant, (*d*) carelessness in disposal of lunch scraps.
2. Accessible nesting facilities. These are a result of (*a*) structural features of building such as double walls, floors, ceilings, attics, and other unprotected dead spaces; (*b*) poor arrangement of equipment, creating concealed spaces; (*c*) improper stowage of stores; (*d*) careless disposal of trash; (*f*) laxity in cleaning of plant.
3. Easy entry. Even though rodents within a plant are exterminated, new infestations will move in from neighboring premises if entry is not barred.
4. Infested environs may contribute inexhaustibly to rodent population as in waterfront areas, low-class residential areas, vicinities of freight terminals, or warehouse districts.

B. Determination of plan of attack against rodents and against causes of infestation

1. Extermination of rodents by killing alone is generally of limited effectiveness because of reinfestation from surrounding premises. Community clean-up campaigns are of only transitory benefit. Therefore, the problem lies almost entirely within the plant and is twofold: (*a*) prevention of reinfestation from without, and (*b*) extermination of rodents within the plant.
2. Prevention of reinfestation from without the plant would mean complete ratproofing of the premises. This may not be feasible except in certain new buildings, and it may not be necessary if the important food storage and processing areas can be isolated and ratproofed and if strict general sanitation is practiced.
3. Extermination of rodents within the plant involves not only killing, which may be very difficult to accomplish completely, but also elimination of the primary causes of infestation: (*a*) food, and (*b*) harborage. Denial of food to rodents depends on ratproof storage of food stocks, careful handling of foods to prevent spillage, effec-

tive cleaning of equipment, thorough housecleaning of entire plant, sanitary disposal of wastes. Denial of harborage to rodents depends upon eliminating or ratproofing dead spaces in the structure of the building, arrangement of equipment and stores to prevent concealed areas, prompt and effective disposal of trash.

IV. Methods

A. *Ratproofing* involves construction and maintenance of buildings or parts of buildings so that no rodents can enter, and requires continuing attention since proper use of structures is as much a part of the program as original construction.

1. Solid concrete or masonry is best permanent ratproof construction and requires little upkeep. Ratproofing must be practicable and not too drastic.
2. No surfaces of floor, walls, or overhead should have any openings of more than ⅜ inch which are not protected by hardware screens, gratings, or doors. All exposed outer surfaces must be made of materials which rats cannot gnaw. Floors should be concrete, foundations or curtain walls 2 feet into ground, ventilators screened with hardware cloth, metal pipes, and conduits cemented in place.
3. Doors and windows tight-fitting and closed when not in use. Where rodents are particularly bad and warehouse doors must stand open for long periods, half doors with sheet metal face, hinged to swing either way, have been effective in excluding rats. Broken drain coverings are entrances for rats.
4. Double walls provide passage from one level to another; also ideal nesting spots. They should either be eliminated or stopped by inserting metal or concrete at bottom of wall between joists and studs.
5. Trees should be trimmed away from buildings and wires.
6. Flour, sugar, and other ingredients should be stored in ratproof rooms.
7. See chapter v, "Construction and Equipment"; also see Bibliography, for additional information.

B. *Rat killing:*

1. *Poison* is an effective weapon against rodents. Poisons are dispensed in various ways. Box-type feeders admit only rodents and shield bait from other animals and men. Small "torpedoes" made of waxed paper 4 in. square with bait wrapped within are sometimes

used. Milder poisons are considered undependable. Newer poisons are being developed.

a. Precautions:
   1) Poison baits must be kept out of food-preparation areas.
   2) State Department of Health should be consulted before using poison; some states require licensing of persons using poisons.
   3) Management should be fully informed.
   4) Responsible and trained person must be in charge of work. Strict account of poison should be kept. Recording of location and daily collection of baits is suggested. Custody of poisons is important.
   5) Collected baits must be permanently disposed of where no harm can result. Burn or bury if necessary.
   6) *The possibility that poison may reach food products must always be kept in mind.*

b. Thallium sulfate.—Cumulative poison, high toxicity, no odor or taste or warning property, slow-acting (72 hours). Most effective poison but dangerous to use; some states limit its use to authorized persons. Sample bait: Thallium sulfate, ¼ oz.; water, 1 large cup; corn sirup, ½ cup; bacon, 12 oz.; glycerine, few drops. Warm, stir well. Slice 2 loaves of bread thinly. Spread poison evenly over each slice firmly, pressing into bread. Cut bread into small squares, place several in a heap.

c. Arsenic (As_2O_3).—1 gram of 10 per cent arsenic mixture is lethal in 48 hours. Rats can detect this poison and do not eat much; hence a higher proportion is required. This is one of the most common and effective poisons. Treat 100 lb. grain with 1 pt. corn oil to make arsenic adhere. Five per cent ground meat garnishes. Arsenic should be finely pulverized. Variable toxicity at times, thought due to grease in foods. Coconut, bananas, fruits, vegetables work well with arsenic. *Disadvantage:* Highly toxic to men and domestic animals.

d. Red squill.—Almost specific poison for rats, harmless for men and domestic animals. Slow-acting, permits rats to leave premises. Some authorities consider toxicity too low.

e. Barium carbonate.—Tasteless, odorless, only mildly toxic, kills after 24 hours. *Disadvantages:* Larger rats may note its effects and stop eating before taking a lethal dose. Toxic to domestic animals and man.

f. Phosphorus.—Zinc phosphide mixed with ground bread or cereal and spread on bread as a phosphorus paste. Use in dry air. Yellow stick phosphorus is dissolved in carbon bisulfide; 2 per cent in bait is effective. Paste is generally used in greasy types of baits. Phosphorus is dangerous to domestic animals and man; it is one of the strongest stomach poisons.

g. "1080" (sodium fluoroacetate).—Wartime development, not yet released to civilian use because of extreme toxicity. Very effective for rodents; 3–6 milligrams will kill Norway rat; 0.1 milligram will kill roof or black rat.

h. ANTU (Alpha-naphthyl thiourea).—Wartime development. Fine gray insoluble powder, little odor or taste. Twice as toxic as thallium. Comparatively nontoxic to humans and animals; induces vomiting. Causes lung edema in rat. Toxic to Norway rat; nontoxic to Alexandrine and Black rat. Need more information before general use recommended.

i. Strychnine.—Very toxic to men and animals, bitter taste, not generally used.

j. *Extreme caution is necessary in handling all poisons.*

k. Virus.—In Europe three types of bacteria have been used to small extent against rats. All three types belong to *Salmonella* group causing gastrointestinal disorders in man. Rosenau says they are ineffective against rats and are threat to man. Rats may develop immunity to these organisms and become carriers. *Not recommended.*

l. These notes are not intended to serve as substitute for authoritative, comprehensive, and varied data on poisons contained in references listed in the bibliography at the end of this manual (see esp. p. 81).

2. *Trapping.*—Traps should be set in obscure places and along walls or in covered runway made by leaning board against wall. They should be left in different ways; some camouflaged with sawdust or paper, some baited but unset. No use in setting trap in open. Efficiency of trap may be increased by enlarging trigger surface with stiff cardboard or sheet iron. *Advantages over poisoning:* Not dangerous to men or animals. makes carcass disposable. *Disadvantages:* Ineffective where rats are excessive. Time required to overcome suspicion of rat. Skill required of trapper. Authorities disagree as to whether or not odor of man's hand deters rat.

3. *Natural enemies.*—Cats are sometimes effective in keeping small rodents down. Large rats will attack cats. Terrier most useful animal against rat. However, no animal has any place in food plant. Cats and dogs are as objectionable in plant.
4. *Gassing:*
   a. Cyanide gas (HCN).—Effectively used aboard ships and in burrows. Chloropicrin has sometimes been added to indicate presence of gas. This gas is unique in that it kills insects and attendant fleas. In the form of calcium cyanide dust this agent is useful in dusting in burrows; moisture of earth tends to liberate HCN. *Licensed operators only should be used for inside gassing. Disadvantages:* Cyanide in any form is highly toxic to man, can become fatal within very short time.
   b. Methyl bromide (CH_3Br).—Very effective gas for both rodents and insects. Can be fatal to man without warning since it has no odor. Halide light may be used to indicate presence of gas. Should be used only by experienced operators.
5. *Pest-control operator:*
   a. Advantages—
      1) Good for very small factories if experienced personnel not available for work or if infestation is very light.
      2) Also might have place in small buildings, stores, churches, etc.
   b. Disadvantages—
      1) Pest-control operator will not be around daily to pick up dead rats or poison bait.
      2) There is no means of checking his effectiveness; operator knows situation better than plant manager.
      3) Operator knows that he will not have a job after rats have gone. Only bonded men with state license should be considered for this work. Plants with Sanitarian should need no pest-control operator.

V. Suggested Procedure for Canning Plants

A. First step in any rodent program is survey with notebook and flashlight to determine:
   1. Extent of problem.
   2. Source of rodents.
   3. Location of rat harborages.
   4. Source of food supply.

5. Most suitable method of attack. Following points are relevant:
   a. Live rats: Each live rat seen indicates 10 to 20 more.
   b. Dead rats: Fresh dead rats, partly eaten, particularly when great part of viscera has been consumed through single hole in body wall, indicate presence of live rats. Condition of mammae may indicate nursing female.
   c. Droppings: Most frequent and dependable indication of rodents.
   d. Runways: Dirty body leaves marks on walls, floors; indicates direction or location of harborages and runways.
   e. Tracks: Certain indication of presence of rodents.
   f. Gnawed materials: Gnawed fresh foods lose their appearance in 24 hours; wood loses fresh appearance after about one week. Large number of freshly gnawed places would indicate many rodents.
   g. Nests: Prove the presence of rats and their efforts at multiplying. Condition of droppings will indicate whether nest is recent or has been abandoned.
   h. Rat odor: Musty odor characteristic of rats invariably present with rats; may linger after rodent departure.
   i. Damaged materials generally at hand to verify presence of rats.
   j. Undue excitement of domestic animals will betray rodents.
   k. Rats urinate frequently. Surfaces or food so contaminated will fluoresce under ultraviolet light. (Not a specific test because other substances are fluorescent also.)

B. Eliminate rat harborages. Three general types:
   1. Structural: Double walls, spaces between floors and ceilings, beneath basement floors, and floors resting directly on ground.
   2. Incidental: Furniture, fixtures, equipment, etc.
   3. Temporary: Stored materials, if left undisturbed for several weeks.

C. Thorough ratproofing and maintenance is second step toward elimination.

D. Deny rats a source of food. Ratproof food-storage rooms or warehouses. Seek coöperation from everyone in plant in keeping doors closed, lunch scraps and other possible sources of nourishment secure against rats.

E. Neatness is important in keeping place free from rats. Piles of lumber and miscellaneous heaps of equipment harbor rats. In outdoor areas, materials should be piled neatly on platforms 12 to 18 inches above ground. Rats do not feel safe in such open places and avoid them.

F. Publicize the danger of rodents.
G. Trapping can be carried on continuously.
H. It may be advisable to remove harborages and food supplies in areas adjoining factory property.
I. Because of varying conditions of climate, plant location, design, and environment the strategy of battle against rats must vary. No single line of attack can be counted on to be successful.
J. Valuable information should be available at rodent-control offices of local and state health departments.
K. Prebaiting should be used in trapping and poisoning to:

1. Gain confidence of rat that is suspicious of new bait and to prepare him for poison.
2. Determine approximate number present: weigh food and divide by 25 grams.
3. Determine effectiveness of kill: 60 per cent is expected.
4. Show best and least acceptable baits. Rats may refuse some baits. Meats, grains, pastry bread, vegetables, edible oils, and fruits have been used successfully as baits.
5. Show best location for baits and traps.
6. Allay natural suspicion the rat may have toward a trap by baiting and not setting the trap until he is accustomed to approaching the trap and taking the bait.

There may be no results for one week. Bait should be in small pieces to prevent animal from removing enough for supply. Graphing the amount of food against time is useful. Bait should be picked up and issued daily, should not be left out during daytime.

VI. General Remarks on Combating Rodents

Through centuries the rodent has developed persistence and cunning while being hunted by men; only the successful have survived. Operations against rodents must be well planned. Scientific weapons, modern construction materials, and ingenuity are requisites for his destruction.

VII. Permanent versus Temporary Control

Any rodent-control program should aim primarily at rodent elimination. There is no compromise with the wanton destruction and insidious public health threat of these animals. Any measure aimed short of complete annihilation of the rodent is quite fruitless because of his remarkable

ability to reproduce and invade on a gigantic scale, thereby wasting money and nullifying efforts expended in halfway procedures.

INSECTS

Control of insects in food plants is a necessary part of sanitation not only because of the benefit to public health but also because of the aesthetic and economic values. Contamination of food products by insects can mean the difference between success or failure of a business. The consuming public is demanding through government representation that food products be free from insects, insect larvae, insect excreta, and parts of insects. The producer must satisfy this new concept of public sanitation if he is to continue successful selling of his products to the public.

We shall consider briefly in this section some of the important insects commonly found in food-processing plants, such as the common house fly, lesser house fly, vinegar or fruit fly, cockroaches, ants, bees and wasps, crickets, stored-product insects, and termites, with no reference to field insects.

The life cycle of insects is called metamorphosis. The complete or complex metamorphosis consists of four stages: egg, larva (maggot), pupa (resting), and adult. Not all insects go through this complete cycle. Insects are often troublesome, at any stage, to food packers.

I. Housefly (*Musca domestica*)

A. Characteristics:
1. Grayish to black in color, four narrow black stripes on thorax.
2. Cosmopolitan in distribution.
3. Breeds in fresh animal manure, human excrement, garbage, and decomposing animal and vegetable matter.
4. Complete metamorphosis. Female deposits in a lifetime of two months 600 to 900 eggs, which under favorable conditions develop in eight days.

B. Control:
1. Screens.—Complete screening is not always practical under operating factory conditions.
2. Sprays.—Petroleum base with pyrethrum extracts, rotenone extracts, aliphatic thiocyanates (lethane), etc.
3. Poisons.—Two or three teaspoons 40 per cent formaldehyde, one pint equal parts milk and water, and two or three teaspoons sugar. Pour on bread in saucer.

4. Traps.—Electric and screen.
5. *Important:* Control the source of the flies. They are usually breeding near by. Treat garbage, fruit, and vegetable piles, etc., with borax, turpentine, dilute creosote, or almost any oil product. Best of all, eliminate breeding places in vicinity of the plant.
6. D.D.T.—Very effective against flies. Suitable for outside use. Use on interiors is questionable since material has some toxicity to humans. In insects it causes a nervous excitability which might predispose them to contamination of food in preparation.

II. Lesser Housefly (*Fannia canicularis*)

A. Characteristics:
1. Smaller than housefly.
2. Three dark longitudinal stripes on thorax.
3. Most common in spring and early summer.
4. Hovers in midair and flies to and fro.
5. Breeding is similar to that of housefly.

B. Control:
1. Similar to that for housefly.

III. Vinegar or Fruit Fly (*Drosophila melanogaster*)

A. Characteristics:
1. Very small, sometimes called gnats.
2. Tan-colored head and thorax, blackish abdomen with underside grayish.
3. Cosmopolitan in distribution.
4. Breed in rotting and fermenting material. They complete metamorphosis in 12 to 13 days under favorable conditions. Female deposits about 500 eggs.
5. The larvae feed on yeast in fermenting fluids.

B. Control:
1. Most important is the elimination of rotting and fermenting fruit and vegetable material.
2. Fly sprays and D.D.T. are effective.

IV. Cockroaches

A. Common types:
1. The American (*Periplaneta americana*): 1½ inches long, reddish brown with light markings on thorax and has fully developed wings.

2. The Australian (*Periplaneta australasiae*): More than 1 inch long (slightly smaller than American), yellow margin on thorax and light yellow streaks on sides at base of wing covers.
3. The Oriental (*Blatta orientalis*): 1 inch long, dark brown to black in color. Male has fully developed wings; female, rudimentary wings or lobes.
4. The German (*Blatella germanica*): ½ inch long, dark yellow or light brown color with two dark brown streaks on the thorax.
5. The brown-banded (*Supella supellectilium*): ½ inch long, lacks the two dark stripes on thorax of the German roach. Wings are twice banded with brownish yellow stripes.

B. Characteristics:
1. Favor warmth and moisture.
2. Omnivorous—they will eat almost anything, but favor starchy materials, sugary substances, and meat products.
3. Eggs are laid in capsules and emerge as nymphs which molt several times before becoming adult, whence you may see roaches of different sizes.
4. Roaches are very prolific, and some species live as long as 2½ years.
5. They hide in cracks, crevices, around pipes, etc. The Oriental favors basements and under areas of buildings.

C. Control:
1. Three pints sodium fluoride powder and 1 pint pyrethrum powder is a mixture particularly effective against the German roach.
2. Phosphorus paste is a preferred method against the American, Oriental, and brown-banded roaches; distributed on a bait.
3. Distribute dust with a blower into cracks, etc.
4. Poisons can be purchased in containers or traps which protect them from accidental poisoning.
5. Sanitation is one of the most important control measures. Keep the premises dry, tight, and clean. Seal and fill up cracks and crevices.
6. Traps may be made from upright jars. Bait is placed inside. Vaseline smeared inside prevents escape. Roach powder in the bottom kills the roach.
7. Sprays are satisfactory if the roach can be wet, but this is seldom possible except with power sprayers.
8. Fumigation.—The German roach is susceptible to fumigation; the American and Oriental are less so. Roaches often enter from outside and therefore defeat the purpose of fumigation.

9. Dry heat can be used if the temperature can be raised to 190° in the building or room.
10. Repeat control measures every week or two to kill the roaches emerging from the eggs.
11. *Caution:* Sodium fluoride powder and phosphorus paste are poisonous to humans and must be used with caution.

V. Crickets

House cricket (*Gryllus domesticus*), field cricket (*Gryllus assimilis*). The two are similar except for breeding habits.

A. Characteristics:

1. Prefer warmth.
2. Nocturnal, pugnacious, and predacious.
3. Light yellowish brown, with three dark bands on head and long, thin antennae. Field cricket is larger and more robust, and wings project beyond wing covers like pointed tail.

B. Control:

1. Usually originate in dumps. Cover the dump with 6 inches of dirt to protect it or dose it with poison.
2. Poison bait.—Sodium fluosilicate and bran scattered below top layer of refuse or under boxes, boards, etc., outside of building.
3. Pyrethrum dust, sodium fluoride, and liquid insecticides may be applied to hiding places in cracks and crevices just as in cockroach control.
4. Sodium fluoride and pyrethrum in a ring around dry oatmeal darkened with a box cover.
5. They will sometimes drown in beer, sweetened vinegar, and other liquors.

VI. Ants

There are numerous kinds of ants, with different habits and means of control. If the ordinary control measures are not successful, investigate the possibility of special measures for the particular type of ant.

A. Characteristics:

1. Ants as a group have a wide range of foods: sweet, greasy, starchy materials and plant and animal materials of all kinds.
2. Ants are numerous and widespread and adaptable to almost all varieties of environment.

3. Usually they nest in the earth and the colonies may outlast a generation of man.
4. The worker lives from 4 to 7 years and the queens as long as 17 years.

B. Control:

1. Poisons.—Baits containing thallium sulfate or sodium arsenite are the most common. Usually used as a sirup or jelly and in a protecting container. *Caution:* Poison; handle accordingly; be especially careful to protect children and pets. Place where they cannot reach them.
2. Pyrethrum powder, derris dusts, and liquid sprays give quick but temporary relief.
3. If the nest can be found it can be destroyed by enlarging the opening with a pointed stick and inserting carbon bisulphide. Petroleum oil is also helpful. The ground saturated with crankcase oil discourages nesting.

VII. Wasps

A. Characteristics:

1. Identify by nests.
2. Feed on liquids and solids.
3. A mean pest, particularly if disturbed.

B. Control:

1. Carbon disulphide for nests in ground.
2. Calcium cyanide for chimneys, etc. *Caution:* This liberates a dangerous gas. Do not use in interiors or occupied areas. May require licensed operator.
3. Contact sprays into nests.
4. Poisons are dangerous and not very satisfactory.
5. All but the queen die about the end of July.

VIII. Bees

A. Characteristics:

1. Most species unmindful of man as long as they are disregarded.
2. Are most often troublesome when swarming in or around buildings or when attracted to sugar.

B. Control:

1. An experienced beekeeper can manipulate the bees by means of a bee-excluder so as eventually to rid the area.

2. Calcium cyanide dust is effective. *Caution:* This liberates a dangerous gas. Do not use in interiors or occupied areas. A licensed operator may be required.
3. Remove comb and honey, and spray occupied space with phenols or cresols to prevent reoccupation.
4. 20 per cent D.D.T. dust is effective if used cautiously.

IX. Stored-Product Insects

There are a number of types of beetles, moths, and weevils which have different characteristics and control measures.

A. Characteristics:

1. Infest stored flour, meal, grains, dried fruits, cured meats, spices, and nuts.
2. Usually enter in infested material and infest other materials.
3. They can enter through extremely small cracks and crevices. Most of them are smaller than a kernel of grain.
4. They bore holes in packages.
5. Leave webbing and feces.
6. Some bore into wood.
7. Some are weak flyers, but most crawl.

B. Control:

1. Eliminate source such as neglected box of food materials.
2. Heat to 140° F. for 10 to 15 minutes all parts where insects are.
3. Clean out old stocks.
4. Clean bins, boxes, etc., and spray with insecticides. D.D.T. is effective if used with caution.
5. Fumigation rarely eliminates all the insects unless conditions are ideal.
6. Rodent and bird nests are often sources of infestation of some types of stored-product insects.
7. Sanitation is the basis of control.

X. Termites

Importance lies in their destruction of wooden construction. There are numerous types of termites.

A. Characteristics:

1. Six-legged insect; three constrictions: head, thorax, and abdomen. Antennae and mandibles on head. Workers are white, soldiers have elongated head.

2. Diet consists wholly of wood and cellulose material.
3. Long-lived individuals.
4. Self-perpetuating colonies.
5. Social and hidden form of life protected from extremes of heat and cold.
6. Subterranean species because of greater need for moisture require connection to ground by tubes, which are sometimes seen built over concrete foundations. Certain other species do not require connection to ground because need for moisture is less.

B. Control:
1. Insulation of wood from the ground.
2. Good cross-ventilation.
3. Chemically treated wood.
   a. Coal-tar creosote.
   b. Chromated zinc chloride (pressure treatment).
4. If tubes connecting to ground are destroyed, termites in wood will die from lack of moisture.
5. Keep debris cleaned out beneath building.
6. Seal cracks or openings in concrete.
7. Ground treatment:
   a. Sodium arsenite.
   b. Creosote.
   c. Sodium arsenate.
   d. Orthodichlorobenzene.
   e. Anthracene oil.
   f. Monochloronaphthalene.
   g. Beta napthol.
   h. Newer ones are: trichlorbenzene, pentachlorphenol, sodium pentachlorophenate, diphenylamine, and lead arsenate. Magnesium fluosilicate, copper sulfate, and zinc chloride have also been used.
8. Metal termite shields can be used in new construction.
9. Holes may be drilled into infested timbers and poison dust (sodium fluosilicate or paris green) forced in. Liquids are sometimes used in same manner.

There are other types of wood-destroying insects and fungi such as the carpenter ant, powder-post and related beetles, and dry-rot fungi.

XI. Insecticides

Sanitation is the most important factor in insect control. Insecticides are, however, a valuable supplement to sanitation. They may be classified as sprays, dusts, and fumigants, or as stomach, contact, and respiratory poisons. Moreover some act as attrahents, others as repellants.

A. Stomach poisons, primarily used against insects with chewing mouth parts.
   1. Sodium fluoride. Also has a contact effect.
   2. Sodium fluosilicate.
   3. White arsenic (arsenic trioxide or arsenious oxide).
   4. Sodium arsenite.
   5. Paris green.
   6. Calcium arsenate.
   7. Thallium sulfate.
   8. Yellow phosphorus (pastes, sirups).
   9. Borax.
   10. Hellebore.

Almost all the poisons listed above are dangerous to humans and pets and must be used and stored carefully. The different poisons should be investigated for their specific application against the particular insect and situation to be controlled

B. Contact insecticides, applied as dusts, sprays, or aerosols.
   1. Pyrethrum.
   2. Rotenone (derris root).
   3. Thiocyanates (Lethane).
   4. Kerosene (basis of most sprays).
   5. Methylated naphthalenes.
   6. Nicotine.
   7. D.D.T.—Amazingly effective against some insects and not against others. It is sprayed on objects with which the insect will come into contact, rather than on the insects. It has some toxicity to man and may be absorbed through the skin in solutions. It is insoluble in water, but can be used effectively in water suspension. It is advised that this material be seriously investigated before it is used in a food plant. Some states have regulations governing use in food plants.

C. Fumigants.—The more commonly used fumigants are toxic to all forms of life, e.g., insects, rodents, and man. The more toxic ones should therefore be used by an experienced operator. They are required to be licensed in many states. The area or room to be fumigated must be carefully sealed. Some of the commoner fumigants are:

1. Hydrocyanic acid gas (HCN).
   a. Pot method.
   b. Liquid cyanide.
   c. Discoids.
   d. Dust (Calcium cyanide).
2. Methyl bromide.
3. Chloropicrin.
4. Ethylene oxide.
5. Sulphur dioxide.
6. Ethylene dichloride.—A gas less toxic to man. It is inflammable and therefore usually mixed 3 parts to 1 part of carbon tetrachloride.
7. Carbon bisulphide (highly inflammable).
8. Naphthalene (moth balls).
9. Paradichlorobenzene (similar to moth balls).

These fumigants should be thoroughly investigated for their application to insects and situations the control of which is desired.

Chapter III

WATER SUPPLY, SEWAGE, AND INDUSTRIAL WASTES

Water Supply

Food-manufacturing plants use water in great quantities, either as a part of food preparation or for cleaning and washing purposes, and therefore it is essential that an ample supply of "good" water be provided. The desirability of water depends largely on the bacterial, chemical, odor, and flavor contents, and if a source cannot be found which meets the requirements in these regards, certain purification treatments must be applied to make it suitable.

Characteristics of Water and Their Control

POTABILITY

A. *Definition.*—A potable water is one which contains no bacteria capable of causing human intestinal diseases and is aesthetically satisfactory for drinking purposes (free from undesirable odors, flavors, chemicals, etc.). Potable water should be provided for drinking purposes, and for washing of food and food handling equipment.

B. *Use of nonpotable water.*—A nonpotable water supply may be installed for fire protection or other purposes which do not involve the food, but if such a supply is provided, it must be marked as such and should not be used for drinking, washing, or clean-up purposes.

Use of sea water.—Sea water is rather commonly used for fluming and washing of salt-water fish and is not considered objectionable as long as it is reasonably pure. It is suggested that a standard be adopted which will meet purity and *E. coli* requirements specified for "good" bathing beaches (less than 50 *E. coli* per 100 ml.), and that the water be obtained far enough out from shore to prevent contamination with municipal or cannery wastes. It is desirable to construct the line so that water is obtained at a level of about 10 feet below the surface, because by such an arrangement floating debris and sea-floor growths are avoided.

C. *Cross connections and contamination of potable water supply.*—There are many ways in which cross connections and contamination of potable water may result. Some of them are listed below.

1. *Direct connections.*—A direct connection of a potable water supply to a nonpotable water supply with only a valve between them is a bad but common practice in many plants. Under no circumstances should the potable water supply be connected directly or indirectly with the nonpotable water supply.
2. *Back siphonage.*—Back siphonage is one of the commonest ways in which potable water may be contaminated. This type of contamination results from a sucking back of contaminated water into the supply line through outlets, owing to a drop in pressure in the water line. Back siphonage is possible in all installations where the inlets are below the highest possible level of the water in the fixtures, as in toilet bowls, and in certain types of sinks, gutters, flumes, and washing equipment. To prevent this type of contamination, siphon breakers should be installed in the water lines for toilet and similar equipment, and all other installations should be of a type that does not permit the possibility of back siphonage.

   Drinking fountains with bulbs below rims.—A potable water supply may be contaminated by back siphonage from the bowl of a drinking fountain when the water inlet is below the rim of the bowl and the bowl is filled with water because the outlet is clogged.

   Use of improper precautions in the laboratory.—Potable water may be contaminated with undesirable material from a laboratory by back siphonage when a hose extension on the water inlet is allowed to remain below the surface of nonpotable solutions in pans, jars, sinks, etc.
3. *Use of a common water hose for several purposes in a plant.*—If a hose has been used for carrying nonpotable water, it should never be used for carrying potable water.
4. *Piping of sewage over potable water.*—Piping of sewage over potable water-storage tanks may lead to contamination of the potable water from leaks in the sewer line.
5. *Potable water primer and lubrication connections on pumps for nonpotable water.*—Potable water primers on pumps used for pumping nonpotable water may cause contamination of the potable water if the primer line is not closed and the pressure created by the nonpotable water pump exceeds that in the potable water line.
6. *Water-sewage ejectors.*—Water ejectors when used for moving sewage or other nonpotable water may contaminate the potable water line by back siphonage if the water pressure drops.

D. *Water-borne diseases.*—Many human pathogens can survive for long periods of time in water and may be carried from one person to another in this way. Of particular importance are the organisms which cause human intestinal diseases, such as the typhoid bacillus (typhoid fever). Contamination of water with these organisms usually results from human feces which have found their way into the water. Some of the ways in which water may be contaminated with these organisms are discussed below.

1. *Wells.*—Wells may become contaminated by surface water, owing to improper sealing around the casing at the ground level, or because contaminated water follows ground strata to the underground reservoir for the well. To control well contamination the following steps should be taken:
   a. Seal the casing to a concrete block at the top and slope the block and surrounding area so that water will always run away from the casing and well.
   b. Extend the casing above the ground level so that surface water cannot run into it.
   c. Seal the pump motor to the casing so that water cannot run under the motor and into the well.
   d. Extend the casing deep enough to seal off all possible underground contamination (at least below the first hardpan).
   e. Locate the well at least 100 feet from all sewers, cesspools, or other sources of contamination.
2. *Reservoirs, streams, and springs.*—These water sources may become contaminated with disease-producing organisms in several ways, as follows:
   a. By people defecating directly into the water.
   b. By people defecating on land where the fecal material will be washed into the streams by runoff water.
   c. By location of privies, cesspools, or sewers above the water source so that seepage or runoff from these areas will find its way into the water.

   The control of such sources of contamination is not always easy. Privies, cesspools, etc., can be moved, but there is no way of controlling habits of fishermen or hunters.

E. *Methods of testing water for potability:*

1. *The E. coli test.*—This test is used as a check on contamination of water with human fecal material. The test organism is always

present in human feces and therefore its presence in water is usually indicative of such contamination. However, sound judgment must be used in interpreting results from this test because coliforms are also found in the feces of birds and other animals, and therefore water which gives a positive coli test should be investigated further to determine the source of the contamination.

The procedure for making this test will not be discussed here, but can be found in the *Standard Methods of Water and Sewage Analysis* published by the American Public Health Association. However, proper sampling procedures are essential, and therefore some of the important steps in taking a sample are listed below:

a. The sample bottle should be of about 4-ounce capacity and should be fitted with a glass stopper.

b. The top of the bottle and stopper should be covered with a metal foil or paper to protect it from contamination.

c. The bottle should be sterilized in a laboratory either by autoclaving or boiling for 20 minutes.

d. *Collecting sample from a faucet.*—Turn on the water and let it run gently for several minutes; remove stopper from bottle (do not let hands come in contact with water, stopper, or lip of bottle), and fill the bottle about three-fourths full.

   Collecting sample from reservoir.—Hold bottle with hand near bottom of bottle and submerge quickly to about 6 inches; move bottle forward while taking the sample so that water touching the hand will not enter the bottle.

   Collecting sample from a deep well.—Flame outside of bottle quickly and lower into the well by a string to obtain sample.

e. After sample has been taken, insert stopper into bottle and tie a string around the neck (over foil) so that the foil will hold the stopper in place.

f. If the sample is to be run within 6 hours, no icing is needed, but if a longer holding time is necessary the sample should be held on (not in) ice.

g. Tag the bottle and ship to the laboratory making the test. Include on the tag the source of the water, the date of collection, what tests are desired, the name of the collector, and to whom the report should be sent.

2. *Hardness.*—Hardness or mineral content of water is determined by chemical procedures. For a discussion of these methods, see chapter

x of this manual, and the *Standard Methods of Water and Sewage Analysis* published by the American Public Health Association.

3. *Odor and flavor.*—Odor and flavor as they affect potability can be determined merely by tasting the water.

F. *Standards for drinking water.*—Standards for drinking water are contained in the U. S. Public Health Service *Reprint* No. 2440 (from Public Health *Reports*, Vol. 58, No. 3, January 15, 1943, pp. 69–111). To include the standards in this manual would require too much space.

TOTAL BACTERIAL COUNT

A. *Importance.*—The total bacterial counts on water are important because the total number of organisms present in water often has a bearing on the amount of spoilage. This is especially true for water that is used for cooling purposes: a high contamination of this water will often result in spoilage, because cans which have imperfect seams often suck in small amounts of water.

B. *Sampling.*—The same sampling technique should be used for taking total count samples as that described above for *E. coli* tests, except that the samples should be iced immediately and should be run within a few hours after sampling.

ODORS AND FLAVORS IN WATER

A. *Cause.*—The odor and flavor of water are caused by dissolved organic and inorganic chemicals, and by the by-products of waterplant life (algae, etc.).

B. *Importance.*—Flavors and odors of water are of economic as well as aesthetic importance, because those which often result from the presence of phenols or phenol-like compounds will impart flavors to the product. This is especially true when the water is chlorinated because chlorine unites with phenol to produce a strongly flavored chlorophenol (the taste resembles the smell of carbolic acid). Only very small amounts of these chlorophenols produce undesirable flavor.

C. *Source of substances producing flavor and odor:*

1. Industrial wastes: oils, gases, salts, toxic chemicals, etc.
2. Bacterial growth on organic matter in water; H_2S (hydrogen sulphide gas), etc.
3. Algae, plankton, etc., growing in water: fish, earthy, phenolic, and other flavors.
4. Steeping of leaves, stems, etc., in water: leafy, woody flavors.

D. *Control:*

1. *Aeration.*—Some odors and flavors can be removed from water by aeration, especially when they result from dissolved gases.
2. *Oxidation.*—Many of the substances which produce odors and flavors in water can be oxidized to odorless and flavorless compounds by use of the following: chlorine, chlorine dioxide, ozone, potassium permanganate, activated carbon or charcoal. Of these substances chlorine is most widely used. It has been demonstrated that "breakpoint" chlorination (described below) will suffice to eliminate most odors and flavors. From the information available it appears that chlorine dioxide is one of the best materials to remove odors and flavors. As its value becomes more widely known, its use will probably become more popular.
3. *Control of algae.*—Covering of water-storage tanks to keep out sunlight will practically prevent the growth of algae and hence will eliminate the off flavors produced by their growth. This method can be rather easily applied where the tank is small. In large bodies of water, or in running water, the growth of algae can be controlled by the addition of copper sulfate. However, this substance must be used with caution because it is poisonous to man and animals. (Above 3 p.p.m. will kill fish.)
4. *Control of source.*—Odors and flavors resulting from industrial sources can sometimes be eliminated by better treatment of the industrial waste.

WATER TREATMENT FOR PURIFICATION

A. *Rapid sand filtration:*

1. *Steps in the operation:*
   a. Coagulation with chemicals such as: alum (potassium aluminum sulfate), aluminum sulfate, ferric chloride, ferrous sulfate plus lime, etc.
   b. Sedimentation and removal of coagulated sediment.
   c. Filtration at rapid rate (125,000,000–200,000,000 gallons per acre per day).
   d. Cleaning of the filter bed is accomplished by reverse flow of clear water through the sand.
2. *Advantages.*—This method is quite rapid and permits flexibility in filtration. Also, this treatment of water removes 98–99 per cent of the bacteria and 99 per cent of the turbidity.

B. *Disinfection of water with chlorine.*—Treatment of water with chlorine will, under proper conditions, kill the bacteria and render the water safe for drinking purposes. Chlorination may be applied to a filtered water to insure complete safety, or it may be used to "purify" an unfiltered water and render it safe for drinking purposes. When water is questionable, chlorination is advised.

Chlorine is commonly added to water in one of three forms, namely: as liquid chlorine, as a hypochlorite, or as a chloramine. Of these three forms liquid chlorine is the most economical to use on a large scale. Chloramines are used in certain industries where a slow action of chlorine is desired (icing of fish). The hypochlorites are handy to use for chlorinating small bodies of water because a solution of the material can be admitted to the water by dripping it from a porcelain or wax-lined container.

1. *Chlorinating with liquid chlorine.*—If liquid chlorine is used, an accurate apparatus must be provided for dispensing it so that the chlorine content of the water can be controlled accurately. Excellent chlorinators are available. The amount of chlorine to be added depends on the chlorine demand of the water and the level desired. Chlorine levels are usually expressed in terms of the residual present in the water after so many minutes, and most workers consider the following as satisfactory for normal water: 0.2 p.p.m. after 5 minutes' contact; 0.1 p.p.m. after 30 minutes' contact, or 0.05 p.p.m. at distant points in the distribution system. However, if an outbreak of disease threatens, the chlorine content is usually increased above these figures. Superchlorination is used by some cities for disinfection of their water supply. With this method the chlorine concentration is run up to 1–10 p.p.m., held for short time, and then reduced by addition of sulphur dioxide, activated carbon, sodium thiosulfate, or sodium sulfite. Experience with this method has demonstrated that it is quite successful, because it kills the organisms and also removes a number of undesirable odors and flavors. Superchlorination has been used in corn and pea canneries without the dechlorination and with no ill effects. The canneries were operated for the season with 5–10 p.p.m. of chlorine residual in all the water being used. It was not objectionable for drinking and was not injurious to the canning equipment. Slime was cleared from all equipment that was constantly sprayed or washed with this water. Clean-up of the equipment thus was made much easier.

Break-point chlorination.—This is fundamentally a type of superchlorination. To explain break-point chlorination, it is necessary to explain what happens when chlorine is added to water. When chlorination is started, the chlorine residual does not increase in proportion to the amount of chlorine added, but rather goes up quite slowly until it reaches a maximum and then begins to drop as more chlorine is added. The drop continues until a minimum point is reached, after which the chlorine residual increases proportionately with the amount of chlorine added. The minimum point is known as the break point. Most chlorine-oxidizeable odors and flavors disappear at the break point.

Water-Storage Tanks

Water-storage tanks are commonly used by most food-manufacturing plants, and frequently little attention is given to their construction and care. Tanks should be made preferably of steel and should be constructed so that they prevent entrance of rodents, insects, birds, and dust.

Sewage and Industrial Wastes

A. *Types of wastes:*

There are primarily two types of sewage: domestic and industrial. Domestic sewage is principally human excreta, laundry water, etc., coming from residences, institutions, and office buildings. Industrial sewage from manufacturing concerns is waste material that is water-carried and discharged into a sewage system. This type of sewage comes from creameries, canneries, packing houses, and other places where food is packed, as well as from commercial laundries, foundries, dye works, etc. We are concerned primarily with the part that canneries and related plants play in sewage disposal.

Industrial wastes are deleterious so far as they contain harmful substances such as chemical poisons, lye, etc. They are also harmful in proportion as their content of organic material breaks down under the action of aerobic microörganisms. This action requires oxygen which is extracted from the water, and the quantity of oxygen necessary to balance the oxygen demand is termed the biochemical oxygen demand (B.O.D.).

In oxygen depletion a point will be reached at which fish cannot survive. If all the oxygen is consumed in the water, the action of anaerobic or putrefactive microörganisms takes place, and the water

is termed septic. The water is grayish or black, gas and odors are produced, and it is generally obnoxious and objectionable.

Treatment of sewage and waste is mostly concerned with preventing the oxygen depletion and the objectionable putrefactive process, either by supplying oxygen, by dilution, by removing organic material, or, by combinations of these methods, to accomplish stabilization of the material.

Municipal disposal systems handle a considerable volume of the industrial wastes of this country. It is quite probable that the load will increase as further restrictions are placed on the dilution method. When it is desired to divert industrial wastes to the municipal disposal system, a preliminary study should be made in coöperation with the managers of the sewage-treatment plant to determine the effect of the additional load on the plant and whether the food processor will need to install pretreatment or to pay for alterations and enlargements of the municipal plant. Because industrial wastes commonly have population equivalents many times that of residential sewage, the absolute volume of an industrial waste is not a true measure of the treatment load. Furthermore, treating industrial wastes in municipal sewage works is not simply a matter of enlarging the facilities to handle greater volume.

Most industrial wastes interfere with the proper functioning of one or more parts of the treatment works, often so seriously as to cause a complete shutdown of long duration.

Further details can be obtained from the National Canners *Bulletin* 28-L on chemical treatment to reduce B.O.D.

B. *Methods of disposal:*

1. *Disposal by dilution.*—Perhaps the most common means of disposal in use at present is dilution: the wastes are discharged directly into large bodies of water such as rivers, lakes, and oceans. This sewage is raw, for the most part, with no previous processing except perhaps trituration to reduce the size of large solids. This practice throws a heavy biochemical oxygen demand on the body of water into which it is discharged, especially the fresh-water streams. The demand might be so great as to deplete the dissolved oxygen to such a degree that the water will not support fish life. A revision of this means of disposal may be required of the concerns now using it; of some of them, not far in the future.

   Wherever this means of disposal is still used, due precaution

should be taken not to overload the stream. If the organic load becomes excessive, a system of screening and settling tanks can be installed. This, together with chemical flocculation, will frequently remove enough of the solids to make it possible to discharge the effluent into a stream without danger of pollution or of creating an unbalanced condition in the stream. If this preliminary treatment will not suffice, it will be necessary to divert the effluent to a municipal plant or to install equipment for further treatment of these wastes.

In some states it is unlawful to place organic wastes in public waters regardless of the effect they have on the stream.

Wastes discharged into marine or salt water require the following precautions: The discharge must be sufficiently deep to be covered at all times. The most favorable tidal currents should be plotted and the waste discharged into these to avoid washing back to shore. Salt water has a tendency to flocculate the solids from sewage which also requires a strong current to avoid accumulations at the end of the discharge pipe. Larger solids sometimes can be ground and discharged into plant wastes in salt-water disposal systems.

2. *Screening of solids.*—Efficiency of all liquid-waste disposals is dependent upon thorough screening. This should be done through a 30-mesh-to-the-inch screen; smaller sizes are inadequate, and little benefit is derived from them. Owing to the size of the mesh, the screens will tend to clog easily. Probably this can best be corrected by frequent cleaning with a steam hose or a continuous water spray.

There is a variety of equipment for screening cannery wastes. Most common are the rotary and vibrating screens. The former are often constructed by the plant, and the latter are usually of commercial construction.

Solids from screens are discharged into bucket or open chain-and-slat conveyors. The conveyors usually discharge into a large holding bin, and the solids are later hauled away.

3. *Garbage disposal.*—Other solids are removed from the plant by screw conveyors and by filling into barrels. When the barrel method is used, steel barrels should be selected whenever possible as these are easier to clean, and carryover of odors and vinegar fly breeding are not so common. These barrels can be washed readily by inverting over a jet with a foot-operated valve; or, if this is not available, washing with a hose will usually suffice.

Due consideration should be given to the use of solid wastes that can be utilized as by-products either by drying or as silage and using as stock feed or manufactured into other products such as alcohol, vinegar, and bland sirups. Often some profits can be realized in this manner, or the costs of disposal minimized. If these solids are hauled away, they may be disposed of at municipal dumping grounds; or, if private disposal is necessary, it may be most economical to dump them in open field areas, isolated so that odors, flies, or rodents will not be a nuisance factor. In some areas the dump can be well covered (2 feet) with earth, which will prevent much of the nuisance danger. Other means of garbage disposal are used, but few are as satisfactory or as applicable to food industries as the fill-and-cover method just described.

4. *Land irrigation.*—Where municipal plants or dilution methods cannot be used, irrigation farms, sand filter beds, and lagoons are used. Both the irrigation and filter-bed methods are intermittent operations, so ample area must be provided. The ground is usually cultivated or disked after each application. Irrigation can be practiced on farm crops, usually orchard or row crops, or applied on special furrowed irrigation farms. In either case the addition of lime may be required to readjust the soil pH. The filter bed is a sandy, level area on which the liquids are discharged intermittently, followed by disking to break up the surface and control weed growth. Both types of disposal should be so located and constructed as to avoid contamination of near-by water. It is important that neither system be located on limestone deposits, as direct drainage causing pollution may occur. If much lye is present in the waste from lye-peeling operations, the filter bed is soon clogged. Domestic sewage is usually acid and has favorable possibilities as a soil-neutralizing agent after the passage of an alkaline industrial waste. Due precautions must be taken not to discharge raw domestic sewage in this manner, as disease outbreaks may result.
5. *Lagooning.*—Lagooning is frequently used where a more direct disposal method is not available. There are two types of lagoons in use:
   a. A series consisting of several lagoons. These are connected in a series with up to 50 per cent of the effluent from the last lagoon being recirculated. Oxygen replenishment is accomplished by surface aeration and by the growth of green algae which produce oxygen during sunlight. The retention period in these lagoons

should be at least 20 days, and the last lagoon often becomes supersaturated with oxygen. The last lagoon is pumped back to the first lagoon to supply the necessary oxygen to control odors and facilitate stabilization by aerobic organisms.

b. The single large lagoon. This is favored in most cannery operations. The size of these lagoons depends upon the depth of the liquid. A depth of 3 feet is considered a minimum depth. 1.02 acres of water surface will be required per million gallons of waste; 4 foot depth, 0.77 acres; 5 feet depth, 0.61 acres.

Depths greater than 5 feet are not recommended. An average of 25 gallons of waste water per case of canned goods packed can be used in estimating the size lagoon needed. This will vary considerably with different products. In the large single lagoon, oxygen replenishment is accomplished through addition of sodium nitrate to supply about 20 per cent of the five-day B.O.D. of the waste. Approximate quantities per 1,000 No. 2 cases are: early peas, 200 lb.; late peas, 150 lb.; corn, 100 to 120 lb.; lima beans, 80 to 100 lb.

For further chemical treatment of lagoons using sodium nitrate it is best to refer to the original work reported in the National Canners *Bulletin* No. 29-L, "Cannery Waste Disposal in Lagoons," Washington, D. C., April, 1945.

Lagoons are usually constructed to dispose of the liquids by leaching into the soil and by evaporation; or by emptying into streams during high water after the waste has been completely stabilized.

6. *Chlorine.*—If offensive odors occur at any phase of liquid-waste disposal, chlorine up to 50 p.p.m. can be added. Fifteen p.p.m. is near the limit that can be used if crop irrigation is practiced.
7. *Trickling filters.*—Trickling filters have been used for the stabilization of industrial wastes, but are not very satisfactory because of the seasonal activity of many plants. Stabilization depends on the biological film formed on the rock in the filter. It takes several weeks for this film to become established after a period of shutdown. The same is true of the activated sludge process.
8. *Chemical flocculation and sedimentation.*—Chemicals such as ferric chloride, ferric sulfate, chlorinated copperas, and alum are sometimes used as an aid to flocculation. Sedimentation is sometimes used both with and without chemical flocculation to remove a portion of the settleable solids from the wastes.

Chapter IV

CLEANING AND SANITIZING

One of the most valuable contributions the food-industry sanitarian can make to his company is to provide an adequate cleaning and sanitizing program for its preparation machinery and equipment. Such a program, broad in conception and detailed in execution, can accomplish the following things:

1. Improve the product by eliminating some of the factors that contribute to quality deterioration.
2. Reduce the loss from spoilage caused by the "seeding" of the machinery and equipment with an objectionable bacterial flora that may affect the keeping quality of the product.
3. Promote consumer acceptance of the company's products through the favorable reaction of the casual visitor to a sanitary plant.
4. Improve employee morale by bettering working conditions.
5. Reduce the possibility of financial loss occasioned by seizure of the company's products by state or federal regulatory agencies.

The sanitarian assigned the task of providing his company with a working program that will accomplish these purposes will encounter some of the following difficulties:

1. Operating schedules so heavy that only a limited amount of time can be allocated to clean-up.
2. Wages of clean-up personnel usually not sufficient to attract qualified workers.
3. Sanitary maintenance disregarded in design of much of the present-day food-plant equipment.
4. Frequent failure to provide basic cleaning equipment.
5. Widespread misconception of the proper role of detergents and sanitizing agents in food-plant maintenance.

While there are no stock answers for these problems and the sanitarian must work out his own salvation in each situation, he must remember that there are certain basic principles involved in attacking his problem.

First, he must realize that sanitation must fit in with production, and not production with sanitation. However, the maintenance of equipment in a clean condition is a production problem and should be handled as such.

Therefore, when operating schedules are heavy, especially when perishable products are being handled, it is important that the clean-up be accomplished with a minimum of interference with production. This will call for a careful study of the problem in order to establish an efficient procedure and to eliminate lost time and unnecessary motion. Time studies and job analysis may prove helpful.

Second, the program must be accomplished with the class of personnel that is available. High-quality workers will not be assigned to this type of work by management. It will take time and effort on the sanitarian's part to break down this barrier and convince management that sanitary maintenance is an important field that calls for highly qualified labor with adequate pay. In the meantime, the sanitarian will be forced to organize his program around inexperienced and unskilled workers. Faced with this problem, he must become a teacher. Intelligent instruction will do much to overcome this lack of experience and skill.

Third, machinery and equipment of insanitary construction usually cannot be replaced immediately with ideal equipment. The sanitarian must consider both the financial condition of his company and the availability of satisfactory replacements. His attack on this problem should be directed toward working out better cleaning methods for equipment until it is possible to secure proper replacements.

Fourth, adequate basic clean-up equipment, such as the proper kinds of brushes, ample water and steam supply, nozzles, etc., must be supplied if the best results are to be obtained. The determination of the types and amount of equipment needed will call for a detailed study of the job to be done and the adaptability of available equipment to the purpose.

Fifth, the sanitarian must keep in mind that cleaning costs money and that it is up to him to decide what degree of cleanliness is desired at any given point in the plant.

Standards of cleanliness are arbitrary, but there are some generally recognized degrees of cleanliness. They are:

1. Physically clean. 2. Chemically clean. 3. Bacteriologically clean.

Physical cleanliness is absolutely necessary, not only because it is the yardstick by which the sanitarian's work will be appraised, but also because without it the other two degrees cannot be realized. The criteria for physical cleanliness are (1) absence of any visible foreign matter, (2) freedom from water spots, and (3) the amount of friction presented to fingers dragged over the cleaned surface.

Chemical cleanliness means freedom from traces of undesirable chemicals, and is judged in a practical way by noting whether the quality of the product has suffered adversely as a result of contamination from the equipment in question, or by actual chemical tests for specific elements.

Bacteriological cleanliness implies a satisfactory bacteriological condition of the entire processing line with respect to the number of heat-resistant spoilage organisms present, as well as to the number and kinds of organisms which reflect the general sanitary history of the product. Both kinds of organisms can be detected quantitatively by bacteriological tests on the object being cleaned, or on the food product itself at various stages in its preparation.

Sixth, the right cleaning aids, such as the proper detergents and sanitizing agents, must be provided. These can be selected only after a careful study of the materials on the market.

The sanitarian, guided by available technical knowledge and the exercise of common sense, must determine by experimentation what detergents and sanitizing agents are best suited to his particular situation. No general rule can be given, as conditions vary from factory to factory, and what can be used to advantage in one situation might prove worthless in another.

An understanding of the properties and usefulness of detergents and sanitizing agents will enable the sanitarian to better appraise their need and probable effectiveness in any situation.

Detergents

There are no all-purpose detergents, and detergents are not vested with any magical powers. Following are some of the desirable properties in detergency:

1. Wetting ability—must wet readily the surface to be cleaned.
2. Emulsifying power—must have power of suspending dirt or soil, such as grease or oil.
3. Deflocculation power—must reduce the formation of adherent masses of insoluble substances during washing.
4. Dispersive power—capable of minimizing film formation and deposition of mineral salts and similar substances on the surface being cleaned.
5. Rinsibility—capable of being easily removed by rinse water.
6. Saponifying power.

In a word, the purpose of a detergent is to prepare the dirt or soil for its subsequent detachment by mechanical action and its final elimination by rinsing. A great deal of cleaning can be accomplished by the intelligent use of plain hot water and elbow grease.

The chemicals which have been used alone or in combination to give the desired properties are, in general, (1) alkali and alkaline salts, (2) acids and acid salts, and (3) special compounds. The following is a brief description of the more important detergents, together with their properties.

Alkaline detergents.—Caustic soda is probably the cheapest detergent and depends principally on brute alkalinity for its action. It is highly corrosive; it hydrolizes proteins and slowly saponifies fats. It is a poor wetter and precipitates calcium and magnesium salts from water, leaving a hardness film. In the milk industry, 2 or 3 per cent solutions have been used for cleaning.

The *silicates* are less corrosive, are good emulsifiers, good wetters and rinsers. They produce less alkalinity and cost more than caustic soda. The silicates range in alkalinity from a very alkaline compound, sodium orthosilicate, down to water glass, which is only slightly alkaline. The detergent value of the silicates depends not only on their alkalinity but also on other factors such as collodial and dispersive properties, and their ability to act as corrosion inhibitors for highly alkaline solutions. The metasilicates are of chief interest and sometimes may be used alone.

As a practical example, in a juice-canning line a 1 per cent solution of caustic soda was used for cleaning. It was noted that deposition of a film occurred. The addition of 0.15 per cent sodium metasilicate prevented the formation of the film. It is possible that the entire cleaning could have been accomplished by the use of the metasilicate alone.

The *phosphates and carbonates* are the principal alkaline salts of interest as detergents.

The phosphates comprise a whole series of salts existing as different ratios of Na_2O to P_2O_5. The crystalline trisodium orthophosphate known to the trade as T.S.P. has been widely used for some time as a cleaner in the food industry. A 3 per cent solution has been suggested for general use. Often, it is used alone or in combination with other cleaners. It is not only alkaline in reaction, but acts as a water softener and emulsifier.

Sodium hexametaphosphate, known as "Calgon," and sodium tetraphosphate, known as "Quadrafos," are most effective as water softeners and possess some dispersive properties. Their chief value is in preventing

and removing water-hardness films when used in proper concentration. A final tetrasodium pyrophosphate, known as "pyro," is receiving more attention as an excellent detergent material. It is a dispersive agent and can combat some degree of hardness by itself.

The carbonates such as sodium carbonate, bicarbonate, and sesquicarbonate, which is an equimolecular mixture of the two, are usually less effective than the phosphates. They are all mild alkalis. Sodium bicarbonate, known as soda ash or sal soda, is used alone for many detergent purposes or as a filler in combination with other detergent materials to lessen their corrosiveness. Thus, causticized ash is a mixture of sodium carbonate and caustic soda. A more effective cleaner might result from the combination of caustic soda and phosphate.

Acid detergents.—The inorganic acids such as hydrochloric and sulphuric acid have little direct use in the food industry. Combined with some corrosion inhibitors they may be of value in scale removal, but their use is not without hazard to the user and the equipment.

Organic acids such as gluconic, citric, lactic, and propionic acids have limited use at the present time because of expense and some corrosive action. However, gluconic acid has been demonstrated to have value in the milk industry in removing from equipment the protein films and other deposits resulting from the continuous use of alkaline detergents. This acid may find extensive application in the canning industry, especially when combined with proper wetting agents and corrosion inhibitors. A commercial compound of such a nature is called "Mikro San." The alternation of acid with alkaline detergents may be a good practice.

Special compounds and surface-active agents.—A large group of new chemicals have appeared which represents attempts to make compounds possessing good detergent and wetting properties without being affected adversely by water conditions. They are of three general types:

1. Cationic, such as "Emulsept," "Hyamon," "Roccal," etc.
2. Anionic, such as "Duponal," "Vel," "Dreft," "Santomerse," etc.
3. Nonionic, such as "Triton," "Intral," etc.

The cationics do best cleaning in acid solution, and the anionics in alkaline solution. The nonionics are less influenced by changes in pH. The cationic and anionic detergents neutralize each other and so cannot be used together. Certain food residues such as lecithin in milk and meat may act as anionic detergents and neutralize cationic detergents. Soap is also antagonistic to cationic detergents. These surface-active agents are

used principally as surface tension reducers or wetters and as sanitizers. They are generally quite effective in low concentrations, but are at present too expensive for general use.

Selection of detergent.—If the sanitarian has a special cleaning problem in which the use of a detergent is indicated, he can experiment with mixtures of the known detergent materials to get the desired results. Once established, the mixture can be purchased on specification from the raw-chemical manufacturers. Often it may be better to obtain from commercial detergent manufacturers the most suitable proprietary mixture, together with the services rendered by such organization. Should the latter course be followed, the sanitarian should have on-the-spot demonstrations of the suitability of the product offered and its method of application.

Application of detergents.—The efficiency of any detergent is increased by the use of the material under pressure and heat. A steam gun with a fin-type nozzle has been suggested for use, wherein the steam is atomized with the detergent at 65 lb. pressure. The use of high-pressure pumps which mix air and water has been suggested also. It was found that air with water at 200 lb. pressure was more effective than water alone at 400 lb. pressure. In closed systems which are not dismantled the detergent should be circulated back and forth a number of times to set up turbulence and increase the time of action. This can be accomplished by using a small portable pump to return the solution from one end of the system to the other through an auxiliary hose or pipe.

Sanitization

If bacteriological cleanliness is desired, the use of sanitizing agents may be indicated. Sanitizers may be considered as those agents which have the property of destroying or inhibiting bacterial growth. All sanitizers are less efficient in the presence of organic matter, and some are rendered completely ineffective. It is imperative, therefore, that the equipment be thoroughly cleaned before sanitizers are applied if maximum effectiveness is to be obtained. The act of cleaning may itself be a sanitizing action by virtue of diluting or removing the bacterial contamination or of killing the organisms by the heat or chemical action of the detergent solution. Steam under pressure can sterilize, but free-flowing steam has little killing effect, especially on large objects. The practice of blowing steam from a hose onto equipment may remove food particles and water, but it is valueless as a bactericidal agent.

There are many chemical compounds which act as bactericides, but there are only three classes of sanitizing agents which are suitable for general use in the food industry. These are:

1. Chlorine.
2. Chloramines.
3. Surface-active compounds.

Active chlorine, usually in the form of hypochlorite, can kill organisms in low concentrations in a very short time. It is easily dissipated by very small amounts of organic matter, however, and it is recommended that the concentration of the chlorine sanitizing solution be at least 50 p.p.m. during the time of use. It must also be kept in mind that the corrosive action and the germicidal action of chlorine solutions vary inversely with the stability. Corrosiveness and germicidal action decrease as alkalinity increases, and vice versa. Chlorine can combine with phenols to produce chlorophenols; hence the quality of the water used and the conditions of use must be known to prevent development of off flavors in the food product itself. Chlorine is easily applied and easily removed and will continue to be the most widely used germicidal material for a long time.

Chloramines are more stable, less corrosive, chlorine compounds which are less affected by small amounts of organic matter than chlorine. The killing action is much slower, however, and the compounds are considerably more expensive than chlorine. If a bactericidal rinse is desired, then a hypochlorite of low alkalinity and high concentration should be used. If an overnight soak can be applied, then chloramines are indicated.

Surface-active agents such as the cationics, Roccal, Emulsept, Hyamon, etc., and the anionics, Duponal, Santomerse, Vel, etc., are relatively new to the field of germicides. These compounds apparently exert bacteriostatic and bactericidal properties in very dilute solutions under proper conditions. The cationics are more effective microbial depressants in alkaline solution and the anionics in acid solution. This is the reverse of their detergent action. Both are markedly affected by the presence of organic matter.

It has been stated that it will probably be a long time before the best methods of practical application of these materials are found and their cost becomes low enough to permit their widespread use. If these materials are offered for use, on-the-spot demonstrations of their claimed effectiveness should be required.

Research

More research is definitely needed in the entire field of detergents and sanitizing agents as applied to the food-processing industry. Until definite methods are forthcoming as a result of this research, the sanitarian must rely on his own experimentation and experience. Since there may be hazards in radical change, preliminary tests should be made before new methods are adopted. Traditional methods should not be disturbed until one is sure of the new, but the validity of traditional methods should be investigated.

Chapter V

CONSTRUCTION AND EQUIPMENT

Construction

The food-industry sanitarian has a definite interest in construction and equipment. Without proper design both buildings and equipment are difficult or impossible to keep clean and the control of insect or rodent pests is complicated.

The duties of the sanitarian are not those of the engineer. Rather, he functions as an inspector who makes recommendations to the operating departments and to the general management, both of which groups must be "sold" the idea of using properly designed equipment.

One of the primary reasons for lack of proper design in new construction and new equipment is the failure of management to provide adequate funds. Expenditures required for sanitary measures are a legitimate part of production costs. The food industry must come to realize that proper design costs money but will effect an ultimate economy. The day when any plant superintendent is considered capable of designing a plant is passing. Designs should be made by capable engineers and architects, incorporating the ideas of the interested individuals, including those of the sanitarian.

The sanitarian should not fall into the somewhat common habit of considering a blueprint as prima facie evidence that a job has been engineered. A blueprint is often prepared by a draftsman whose knowledge is limited to proper drawing technique. All drawings should be minutely criticized, and suggestions should be made for improvements.

Because expenditures for new construction and new equipment are infrequent, the best opportunities to improve existing construction and equipment will occur in the regular repair and maintenance program. Estimates of costs and plans for repairs or maintenance require checking by the sanitarian if advantage is to be taken of his advice on items of sanitary significance.

Buildings.—Buildings for food industries may be of various types. For some operations wood-frame structures may be adequate, while concrete or brick structures may be indicated for others. It is not within the scope of this manual to specify details of construction, but rather to point out general rules, which, if followed, will help toward avoidance of insanitary conditions in the future.

One of the fundamental considerations is the provision of sufficient floor space to prevent congestion. A congested area promotes insanitation because of the difficulty of cleaning, and because in such an area cleaning often interferes with production—which results in a tendency to neglect cleaning.

The design of food plants should avoid, as much as possible, corners, ledges, recesses, or other places which tend to collect debris and which are difficult to clean. The ideal structure would have coved corners and smooth walls, floors, and ceilings. Every effort should be made to "streamline" the structure so far as economics will permit. It has been noted that carpenters and other construction men often produce uncleanable dirt collectors in efforts to make things look fancy.

Floors.—Floors may be made of various materials. Probably the best material for general use is Portland cement concrete. This material has adequate strength, does not of its own accord support bacterial growth, is quite impervious to moisture, and may be easily cleaned.

The sanitarian should not fail to point out that much may be gained by attention to proper specifications for concrete mixtures. Dense concretes are more resistant to organic acids, water, and similar materials than common concretes. Although a knowledge of concrete mixing is claimed by many mechanics and contractors, adequate knowledge is seldom possessed by other than trained engineers.

Under some circumstances other materials may be indicated, for various reasons. In plants where organic acids are used, concrete floors are disintegrated rather rapidly. Here the use of brick, asphalt, or tile is more satisfactory. Economical conditions may dictate the use of wood floors. These are satisfactory only if they are well laid and well maintained. Wood floors must be strong enough not to sag or crack, and should not be made of soft woods which splinter badly. Periodical dressing to render them waterproof and to harden the surface is necessary.

Floors of any material in a food plant must be easy to clean. Since washing is the commonest method of cleaning, it is necessary that the floors be graded to provide drainage. The optimum range of slope is from $\frac{1}{4}$ in. to $\frac{1}{2}$ in. per ft. Too much slope makes washing difficult, since the water runs away and does not float food particles well. Insufficient slope, on the other hand, tends to result in wet floors, which are insanitary and unsafe. Contracts for flooring should include penalties to the contractor for failure to provide complete drainage.

Drainage.—Specifications for floor drains are defined by law in many

communities. It is well to check local and state ordinances, building codes, plumbing codes, and public health regulations.

If open drains are used, they should have vertical sides and rounded bottoms. The longitudinal slope should be from ⅛ in. to ½ in. per ft. It is well to avoid especially deep drains, as they become difficult to clean. A minimum depth of 6 in. under the drain covers should be provided to prevent material from clogging the drain. Some sort of trap should be installed between the drains and the sewage system. Machinery should not be installed over drains, as they should be accessible at all times.

Adequate drainage is seldom achieved in food-preserving plants. This is due not merely to continual washing and to lack of drains, but often to a failure to carry water from washers, scalders, and similar equipment to the drains. Inefficiency and neglect on the part of supervisors and employees contribute to the problem.

Where drains are made from pipe, they should be trapped near the entrance and adequately vented. No drain should be less than 4 in. in diameter. It is highly desirable that drain piping be accessible for repair.

Lighting.—Adequate lighting of the entire food plant is essential to insure the sanitary operation of the plant. It is a valuable aid to the health, safety, and efficiency of workers. Without it eye damage may occur, accidents and spoilage of material will increase, and production will slow down.

The desirable quantity and quality of light for any particular installation depend upon the work which is being done. The degree of accuracy, the fineness of detail to be observed, the color and reflectivity of the work and of the immediate surroundings are factors in determining the type and amount of light which will produce maximum seeing conditions.

To insure that a given illumination will be maintained even where conditions are favorable, it is necessary to design the system to give initially at least 25 per cent more light than the required minimum.

As a general rule the intensity of lighting should be at least 20 foot candles at any surface. Certain operations may require higher values. Studies of lighting in food plants are now being made and data should be available by 1947.

Lighting may be classified as:

A. Natural.
   1. Windows.
      a. Window areas should be at least 30 per cent of the floor area.
      b. Skylight windows give more nearly uniform light.

c. Structures adjoining should be of a light color.
d. Windows on north side prevent glare.

B. Artificial.
1. Direct lighting.
a. Lights are directed downward toward working surfaces.
1) Must be adequate to provide even illumination to all surfaces.
2) Shadows and glare should be avoided.
2. Diffused lighting.
a. Such fixtures are used as will break up direct light, to prevent glare and shadows.
3. Indirect lighting.
a. Light is directed to the ceiling and walls and reflected diffusely to all parts of the room.
1) Walls and ceiling should be a light color.
4. Supplementary lighting.
a. Light is confined to the immediate work area.
1) Lights should be directly over work zone.
2) Lights should be designed for the particular visual task.
3) Proper direction of light diffusion, eye protection, and elimination of direct and reflected glare are important.
4) Objectionable shadows should be avoided.

The proper and adequate maintenance of equipment is essential for both natural and artificial lighting. Systems will soon deteriorate unless properly maintained. They should be kept clean and in good repair at all times.

Ventilation.—Adequate ventilation of the food-industry plant should be provided for when the building is constructed. Poor ventilation tends to contribute to insanitary conditions in the plant, owing to the condensation of vapors and the concentration of offensive odors. Also, it has a direct effect upon the employees.

Quantity of air is not the only consideration. Air must be properly distributed if it is to be effective and comfortable.

The quantities of air required for ventilation vary, and the following factors should be considered in determining them.

1. Size and type of building.
2. Number of employees.
3. Atmospheric conditions.
4. Amount of steam, dust, and gas produced by operations.

Proper ventilation can be accomplished by either or both of the following methods:

1. Natural.
   a. Adequate screened opening to outside.
      1) Ceiling vents; hood vents.
      2) Windows.
      3) Doors.
2. Mechanical.
   Numerous mechanical systems can be employed to insure adequate ventilation. Some of the simple types are:
   a. Unit blowers, for heating and ventilating.
   b. Window ventilation with exhaust.
   c. Unit cooling systems.
      1) Costly to install and maintain.
      2) Evaporative cooler simplest type.

It has been observed that the mean effective temperature for comfort in summer is 71° F. and in winter about 66° F. (air movement about 20 ft. per min.). The relative humidity for comfort should be maintained between 30 and 70 per cent.

Water supplies.—Care is necessary in installing a water-distribution system in a food-industry plant to prevent possibility of contamination of potable water by cross connections or back siphonage.

1. Sanitarian's responsibility is:
   a. Presentation of the subject to those responsible.
   b. Education of those concerned to the need of consideration of the problem.
   c. Knowledge of state or other governmental regulations.
2. Cross connection is a connection between any part of a water system used or intended to supply potable water, and nonpotable water which may be forced or drawn into the potable water system.
   a. Prevention:
      1) Elimination of the cross connection.
      2) Use of double check valves.
      3) Use of air breaks or gaps.
      4) Inspection.
      5) Education.

3. Back siphonage is the flow of nonpotable water into a potable water system. Such flow may be caused by gravity, vacuum, or other pressure differential.
   a. Causes of back siphonage:
      1) Water pressure failures due to broken pipes.
      2) Fluctuations in pressure or quantity of water supply.
      3) Improperly designed or undersized pipe distribution systems.
      4) Heavy demands for water, such as suction of fire pumps during fires, or heavy use on lower floors.
   b. Conditions under which back siphonage may occur:
      1) Under-rim plumbing fixtures.
      2) Flushometer valves.
      3) Pumped sumps for buildings.
      4) Submerged outlets.
   c. Methods of preventing back siphonage:
      1) Proper installations in new buildings.
      2) Surveys of existing plumbing and correction of defects.
      3) Enforcement of adequate modern plumbing codes.

Ratproofing.—Proper construction and maintenance of a building will keep rodents out of a plant. The best time to ratproof a building is when it is built. However, alterations and small structural changes in older buildings can often make them relatively ratproof.

The simplest form of ratproofing is accomplished by closing all openings in the exterior walls of the building to prevent ingress of rats or mice.

1. Foundations:
   a. Concrete 18 to 24 in. into the ground.
   b. Twelve inches of concrete outward at right angle of bottom of foundation to prevent burrowing under foundation.
   c. Concrete extended 12 in. above ground.
   d. Curtain walls of sheet metal or hardware screen can be used to accomplish the same purpose; but this is a temporary expedient.
2. Basements:
   a. Concrete to prevent ingress.
   b. Openings for piping should be well sealed with concrete or metal.
   c. Eliminate or close spaces between basement ceiling and floor above.

3. Walls:
   a. Prevent double walls if possible.
      1) They provide harborage and runways for rodents.
      2) Seal around openings for ventilators, pipes, etc., with concrete or masonry, or tin sheeting.

4. Openings:
   a. Windows and wall ventilators, etc.
      1) Close with galvanized wire cloth of $\frac{3}{8}$-in. mesh, 19-gauge or heavier.
   b. Doors:
      1) Should be well fitted, and metal-edged at bottom to prevent rodents from gnawing and obtaining entrance.
      2) Should be closed when not in use.

5. Loading platforms:
   a. Seal underneath loading platforms to prevent harborage for rodents.

Equipment

The canning industry in the past was made up of a large number of small units. The size of the plant was controlled by the amount of produce which could be grown in its immediate vicinity. With the introduction of the modern truck the growing area has greatly increased, resulting in larger cannery units, and for the first time allowing large expenditures for equipment. Whether or not these expenditures will be for properly designed sanitary equipment will depend upon how well the sanitarian overcomes resistance to change and how well he convinces the industry that arguments for proper design are valid.

The sanitarian will have interest in two classes of equipment, namely, that built in the food plant by its own mechanics and that manufactured by other concerns. It is difficult to state which class is of most insanitary construction. In both classes mechanical genius has run wild, producing machines of mechanical consideration only, with the result that they are often difficult or impossible to clean.

The equipment built in the plants should be designed to eliminate all possible recesses. The use of wood should be discouraged as much as possible. Tanks, vats, scalders, blanchers, and similar pieces of equipment should be so designed that they may be opened for cleaning and inspection. The size of such openings should be large enough to make access easy.

The use of angle iron in conveyors is not recommended. Its angles are

difficult to clean in the straight sections and extremely difficult to clean at the joints. Tubular sections are more sanitary and provide greater strength per unit of weight. Welding of joints also creates more sanitary conditions through elimination of crevices where bacteria or maggots may develop.

Use of sanitary tubing is desirable. Descriptions of this type of tubing may be found in most food-industry equipment catalogues. It is available in several metals and in glass.

Canvas or cotton belting is seldom suitable for use in food plants. Rubber or metal belting, being washable, is preferred. Stainless steel belts are high in cost but easily cleaned.

It is well to consider the new noncorrosive materials which are becoming available. The list of noncorrodible materials now includes stainless steel, glass, plastic, various bronzes, aluminum, aluminum alloys, ceramic materials, and other alloys.

Great improvement can be made in equipment during maintenance and repair. The sanitarian should make a survey of equipment and outline improvements for the mechanical department. Budgets should provide for improvement of existing equipment. The equipment purchased from machinery manufacturers is often of poor sanitary design. The food machinery manufacturers are reprehensible in their failure to consider sanitation adequately. The sanitarian must continually point out the defects pertaining to sanitation. Choice of a machine should depend upon its sanitary as well as its mechanical aspects.

Equipment should be easily dismantled for cleaning. There should be no recesses where debris may collect. A uniform straight-line flow of material is desirable so that food is not allowed to collect at one spot and stand over prolonged periods.

Equipment should be so constructed that spillage is trapped and conveyed to drains rather than allowed to fall on the floors. Such equipment as mechanical peelers, pitters, and others producing solid wastes should incorporate sanitary means of delivering the waste to the disposal equipment.

Chapter VI

WAREHOUSING

WAREHOUSING relates to storage of raw materials, ingredients, finished products, miscellaneous equipment, and containers.

Sanitation applied to warehousing is a large field about which much has been written. Briefly, the following topics should be given due consideration.

1. *Raw products.*—Raw products should be transported in clean, sanitary containers which should be cleaned with live steam or hot water jets immediately upon removal of the product. This procedure is more effective than waiting until the waste material has remained on the containers for some time.

2. *Inspection.*—All products should be inspected for quality and for rodent or insect contamination. The methods of handling these problems are taken up more thoroughly in other sections of this manual.

3. *Storage.*—After the product is inspected it should be stored in a clean, cool, well-ventilated area that has been rodent-proofed. This should be laid out so as to facilitate the most rapid handling and to insure that the first material received is the first processed.

In storage of the finished product, the warehouse area should be a clean, preferable concrete structure that is laid out in sections. This method tends to keep the warehouse orderly by giving the tractor drivers a definite location and lines for placement of pallets. It gives an over-all appearance of good warehousing.

Sugar and salt should preferably be stored in a separate rodent-proofed section of the warehouse, but if an honest endeavor is made on the part of the canneries to seal the places of entry and eliminate as many existing rodents as possible, it will do much toward solving this problem. Spices definitely should be warehoused in a separate area, with steps taken to keep it free from any contamination.

In the warehouse a separate area should be set aside for the placement of dents, swells, etc. These should be worked over and disposed of. When the materials are dumped, the cans should either be broken or cut before being hauled away by collectors.

4. *Miscellaneous equipment and containers.*—In the storing of machinery an unlimited area should be available. Machinery should be well cleaned; it is recommended that a thorough steam cleaning and painting

be done before storing. The machinery units should be placed adjacent to one another with a runway large enough to facilitate easy movement in and out of the area.

Large sealing machines or those having surfaces that require constant protection with oil should first be cleaned with either gasoline or kerosene and then sprayed liberally with a fine oil. A moisture-proof container should then be bound securely to it.

This area will present an excellent rat harborage if constant cleaning and good housekeeping is not maintained. The area also offers a place for storage of detergents, etc., since ample room is available for circulation about it.

Containers such as cans and cartons do not present too much of a storage problem. At present they are being received in neat sanitary paper bags which warehouse very well. The broken bags should always be resealed, or the contents should be repacked into similar paper containers before storage. Where containers are received in bulk form, rodent-proof bins should be constructed. When the bins are filled, the contents should be sealed in place by heavy paper and lath coverings to protect them from dirt accumulations and rodent infestation.

Label rooms, because of the condition in which most of them are kept, offer excellent harborages and seem to be an attraction for rats and mice. Good housekeeping should be practiced constantly, and adequate shelving should be provided.

Sanitation of refrigeration:

1. Drain pans should be built under the refrigerating unit, and lines to carry away the slush and moisture during de-icing.

2. The room should be painted or constructed of impervious material having a good resistance to cold and dampness.

3. Small applications of salt to the floor will keep any particles that happen to fall there from freezing and will assist greatly in cleaning.

Chapter VII

INDUSTRIAL SAFETY AND HOUSEKEEPING

SAFETY is of concern to the employer both for monetary and humanitarian reasons. Millions of dollars every year are lost directly through industrial mishaps, and thousands of workers are maimed or killed as a result of accidents in plants. As long as people think and act with some degree of independence, some industrial tragedies will inevitably result; however, many of the accidents occurring today would be preventable, if only some intelligent planning were exercised in the physical outlay of the plant. The food industry is in the unenviable position of having a much higher accident rate than industries with greater accident risks. This condition should be recognized more widely, and intelligent efforts should be made to reduce the rate to a reasonable level. With the foregoing in mind, the following is intended to be but a brief résumé of the conditions resulting in plant mishaps:

Insufficient lighting.—Statistics show that the greatest number of accidents occur during the months of diminished natural light. Dirty windows and insufficient artificial lighting often make conditions much worse than they need be. Great improvement in illumination may be made by using white or very light paints in dark interiors, and at the same time the cost of artificial illumination is reduced.

Overcrowding of machinery.—Any undue curtailment of space interferes with the proper handling of the machines and adds to the risk and probability of accidents because of the exposure of the operator to contact with gears, pulleys, belts, and other moving parts. Under crowded conditions, even when guards are provided in the fullest measure, complete elimination of danger is rarely possible.

Slippery floors.—Slippery floors constitute an element of danger, especially in the presence of unguarded machinery, and even where a slippery floor is not in proximity to an unguarded machine it may still cause a bad fall resulting in serious injury. Falls account for an abnormal number of accidents in food factories.

Lack of knowledge.—Many accidents, often serious, are due to the ignorance of the workman. New employees are put to work on dangerous machines without proper preliminary training or sufficient instructions. Even where apprenticeship is not necessary, new employees nevertheless should work with, and under the instruction of, experienced employees.

All workmen should be instructed, in language they can understand, in the proper and safe way to do their work.

Carelessness.—The importance of this feature cannot be overestimated. In Germany, "out of 45,971 accidents noted in the industrial accident statistics there were 9,363 caused by improvidence or inattention of the worker, 533 by frivolous behavior, 2,422 by acting in contradiction to instructions, 861 by nonuse of existing devices for protection, and 220 by unsuitable clothing." Many accidents may be prevented by the maintenance of discipline, including the application of punitive measures where necessary.

Unsuitable clothing.—Ragged sleeve ends, ties, and coats or overalls not properly buttoned often catch on moving parts of machinery. Under such conditions, workmen should be advised to roll the sleeves of all garments above the elbow. Women should be instructed to wear hair nets. Long strings and flowing garments are to be avoided.

Failure to use safeguards.—Very often, workmen will object to the use of safety devices, claiming that they interfere with the quantity of output and so cut down their earnings. This is likely to be true of piecework. By the exercise of a little ingenuity, however, the guards may often be adapted to perform their function and yet not interfere with the speed of the worker.

Overwork.—Fatigue leads to carelessness, and long hours of labor without rest are responsible for many accidents.

Ventilation.—A continuous supply of pure air is no doubt of greater importance from the standpoint of the maintenance of health than it is from the standpoint of the prevention of accidents, but the two are related. Improper ventilation which leads to fatigue or which fails to remove substances irritating to lungs, eyes, or skin, may be directly responsible for accidents.

Intoxicants.—It is advisable to prohibit the drinking of intoxicants during working hours. No man even slightly under the influence of liquor should be permitted to remain at work. Nor should a man whose nerves have been rendered unsteady by the habitual use of alcohol be permitted to operate dangerous and expensive machinery. He endangers not only his own life, but also the lives of others.

Supervision and management.—Whether accidents are frequent or infrequent will depend in no small measure upon the character of supervision and management. If those in positions of authority are careful and prudent, their conduct will be reflected in the conduct of the workmen.

Managers, superintendents, and foremen should be persons of experience given to exercise of a high degree of care in all they do. Management should provide frequent inspections for care and maintenance of equipment.

General housekeeping.—This is a general classification, and some of its aspects have been discussed earlier. However, such things as aisle ways crowded with excessive numbers of boxes, sacks, tools, cans, and amounts of produce are to be avoided. A plant that is dirty constitutes a definite health and safety hazard, as is reflected by the high insurance premiums on such establishments. Organic refuse scattered about the floor provides an excellent medium for slipping and falling. Greasy handrails, and oily stairs and ladders, are a frequent cause of avoidable accidents. Poor stacking and storage arrangements provide a definite safety hazard.

Disorderly plant surroundings, characterized by unused or obsolete equipment, piles of old boxes and crates, old cans, and refuse on the loading platform constitute potential accident possibilities. One can enumerate an indefinite number of minor so-called "housekeeping problems" all closely related to sanitation and aesthetics.

National Safety Council.—The Council is a nonprofit coöperative association organized and operated to carry out a national educational program for reducing accidents. It is financed through membership dues and public subscriptions. The Council is eager to give fullest coöperation to all who are working to prevent accidents. This information is presented in various ways, ranging from graphic posters portraying one important accident problem to an elaborate plan for the analysis of causes and the prevention of accidents throughout an entire industry.

Safety inspector.—Some plants have a safety inspector, who may be the nurse, sanitarian, or someone else appointed to this responsibility. It is his job to check on the safety appliances, practices, operation of the safety program, etc.

Safety committee.—A large number of food plants have a safety committee made up of employees in the various departments. They meet at regular intervals with the management and go over the accident reports; they also make recommendations pertaining to safety. This is an excellent program and is recommended to all plants. However, a safety committee alone will not suffice for an adequate safety program.

Chapter VIII

SANITARY FACILITIES AND INDUSTRIAL HYGIENE

The sanitary facilities provided for employees are often badly neglected in food plants. The importance of the proper construction and maintenance of these facilities is overlooked, even though they are reflected throughout the plant and in the type of employee.

It is reasonable to expect an employee who has clean and proper sanitary facilities provided to have an improved attitude toward his job and the proper production of the product. It is also possible for the plant to attract a better type of employee. The opposite is true of the dirty, odorous, poorly constructed and maintained facilities, and it will almost always be seen reflected in the employee and his attitude toward his job. Carelessness, inefficiency, absenteeism, and an irresponsible attitude go hand in hand with the insanitation of the sanitary facilities.

There are legal specifications in many states governing many of the following recommendations. State and local requirements should be ascertained. The following are those generally accepted as a reasonable standard:

A. Rest rooms

1. A retiring room should be provided in all work places where ten or more women are employed. Minimum space for this number should be sixty square feet and two additional square feet for each additional woman employed. Rest rooms should be separate from and adjacent to the lavatories.
2. There should be at least one couch or bed in every place where more than ten women are employed. Recommended numbers are as follows:

No. of female employees	No. of beds
10–100	1
100–250	2
Over 250	1 for each 250 additional women

Blankets and pillows should be on every couch or bed. Pillow slips should be cleaned weekly and blankets monthly, or more often as the need arises.

B. Toilets and lavatories

1. Under the labor code of California, for example, Article 2350 states, "There shall be provided, within reasonable access, a sufficient number of water closets or privies for the use of employes, and that whenever five or more of the employees are of different sexes a sufficient number of separate water closets or privies shall be provided for each sex."

   Wherever privies are permitted they should be constructed in accordance with the Specification for the Sanitary Privy, Supplement 108, California Public Health Reports.

2. Separate toilets should be provided for each sex as follows:

Number of personnel employed	Minimum number of toilet facilities
1–9	1
10–24	2
25–49	3
50–100	5
Over 100	1 for each 30 additional employees

3. There should be a sanitary-napkin dispenser in all women's toilet rooms and a covered receptacle in all women's toilet compartments.
4. There should be an adequate supply of toilet paper and proper holders in each toilet room. Adequate washing facilities should be maintained adjacent to the toilet rooms, and shall be supplied with soap, running hot and cold water, and individual paper towels. Toilets and washrooms should be maintained in a clean and sanitary condition.
5. The floors of toilet rooms should be of cement, tile laid in cement, or other nonabsorbent material. They should be constructed with a cove base extending up the wall approximately six inches. Floors should be washed and scoured daily and should be provided with a drain.
6. If urinals are provided, one toilet less than the toilets specified may be provided for males for each urinal, except that the number of toilets in each case must not be reduced to less than two-thirds the number specified.
7. Every building should have convenient toilets or toilet rooms, separate and apart from the room or rooms where the process of

production, manufacture, packing, canning, or distributing is conducted. Maximum distance to any toilet room should be 150 to 200 feet.

Toilet rooms should be fitted with self-closing doors and should not open directly into workrooms. Windows should open to the outside and be equipped with screens.

Cubicle partitions should not meet the floor or ceiling. This facilitates ventilation and easy cleaning.

8. The following is the space allotment for toilet facilities:

Installation	Min. width (in.)	Min. depth (ft.)	Min. floor space (sq. ft.)
Toilet	32	3.6	16
Wash basin	24	3.6	12
Urinals	24	3.6	12

9. Separate hose connections for hot and cold water should be available in all rest rooms and shower rooms, to facilitate cleaning.

C. Showers

1. Adjacent to the locker rooms complete shower facilities may be supplied. The showers should be equipped with hot and cold running water and the room temperature maintained at a comfortable level.

   Duck boards in the floor of the showers should be abolished. The moist wood is a natural medium for the fungus commonly called "athlete's foot."

   As a preventive measure, feet can be acidulated with gluconic acid and then powdered with calcium propionate. Floors in shower rooms should be constructed of an impervious material with floor drainage outlets to facilitate flushing.

D. Locker rooms and lockers

1. Adequate facilities should be provided for employees to change their clothes. Steel lockers with sloping tops will prevent accumulations of clothing and trash. They should be in some part of the plant as remote as practical from contamination by the dusts and dirt of operations. Each employee should have a separate ventilated locker of adequate size. In certain operations double lockers are recommended. Where employees are exposed to excessive heat or water, the working attire becomes damp or wet. Air-circulating systems, distributing warm, dry air, or drying rooms, should be provided for drying this damp clothing.

Good ventilation, adequate lighting, and proper room temperature should be maintained for the comfort of the employees while changing clothes.

The lockers and locker rooms should be maintained in a sanitary condition.

E. Drinking fountains

1. Drinking fountains preferably should be the angle jet type. This prevents the return of the water in the jet to the orifice. The jet should be above the edge of the bowl, to prevent contamination if the drain becomes clogged, because these bowls are frequently misused as receptacles for chewing gum, cigars, and cigarette butts. Drinking fountains should be so placed as to be accessible to all employees in all parts of the plant, with one fountain provided for each fifty employees.

   When economically possible, electrically cooled drinking fountains are advisable. They are easy to keep clean and the water temperature remains constant. A temperature of about 48° is advisable.

F. Dress and uniform

1. Adequate headgear and clean uniforms are advisable for all employees. Uniforms will aid in the general appearance of the plant, and in engendering among employees a feeling of respect for plant cleanliness. It will also assure the wearing of safe, sanitary clothing. Some companies encourage the wearing of uniforms by defraying part of the cost of the uniform and the cleaning of them at regular intervals.

Chapter IX

FEEDING AND HOUSING

Feeding

The problem of feeding of employees has existed in some of the larger food-processing plants and probably will become more extensive in the future. The complexities of the problem have been variable, ranging from no facilities at all (or small lunch counters serving only hot drinks, candy, etc.) to large, well-equipped cafeterias serving balanced hot meals.

One of the tasks of the food-industry sanitarian in organizing a comprehensive plant-sanitation program will be the initiation and maintenance of a satisfactory program of sanitation in cafeterias and kitchens. Education of food handlers through demonstrations, discussions, posters, etc., will be necessary. In many instances, assistance and advice may be obtained from local health department inspectors or sanitarians who are more thoroughly acquainted with local health regulations and who may be more intimately acquainted with problems in food handling.

Food affects health in many ways. Unbalanced diets resulting in diet deficiencies, food allergies, vitamin content, etc., are important considerations. However, as sanitarians, our main concern is in how food sanitation is linked with disease. There are five agencies through which food may cause disease, namely:

1. Toxins that are produced by certain types of bacteria as they grow in food; for example, staphylococci and botulinus organisms.
2. Bacteria that are transmitted in food and produce disease by infecting man; for example, the organisms of typhoid fever, dysentery, undulant fever, scarlet fever, diphtheria, and many others.
3. Animal parasites such as trichina and tapeworms that gain entrance into the body through uncooked or inadequately cooked meats.
4. Poisonous foods such as certain mushrooms, mussels in some seasons, etc.
5. Poisonous substances used as food preservatives and colorings; those entering by accident such as insect poison; poisonous spray residues on fruits and vegetables; and poisons from containers such as cadmium.

Sanitation for cafeterias or lunch counters should be based on a knowledge of the foregoing factors, particularly those concerned with the growth and transmission of bacteria in foods.

Sanitation standards of cafeterias.—Minimum standards for a cafeteria (which may be operated by the company or operated as a concession) should consist of the following: Floors must be of concrete or tile, or of wood covered with linoleum. Tight wood floors may be acceptable if properly maintained. Walls and ceilings should be washable and light-colored and should be impervious near dishwashing machines, sinks, etc. Doors should be self-closing, and windows should be well screened to prevent the entrance of flies and other insects that may contaminate food. Ventilation should be adequate to prevent undesirable accumulations of odors or condensation around the stoves, steam kettles, etc. Exhaust fans and hoods may be used if necessary.

Toilets must have self-closing doors, and must not open directly into any room where food is being prepared. Ventilation must be to the outside, and the rooms must be well lighted. An adequate number of toilets must be provided. Adequate hand-washing facilities are necessary, including warm water, soap, and sanitary towels. Signs should be posted above the wash basins, warning employees to wash their hands after visiting the toilets. Toilets are also a good place to warn against the spread of venereal diseases. Employees should not be allowed to wash their hands in the same sink where dishes are washed.

Lighting facilities should likewise be adequate: in general, an illumination of 10 foot-candles, 30 inches from the floor, is sufficient in working rooms; dining rooms may require less.

Foods on display should be kept in cases that are tight and easily cleaned. Shelves and counters should be kept clean and in good repair. Dishes may be washed in sinks, but preferably in two-compartment dishwashing machines in which the wash water is kept at about 120° F. and the rinse water at 180° F. or higher. A bactericidal rinse of 50 p.p.m. of residual chlorine may be used. It is suggested that plates be well rinsed or scraped of food before being stacked in trays for the dishwasher. Dishes should not be stacked so closely together that the sprays of water cannot strike and wash all parts of the utensils. Extreme care should be taken to operate these machines according to instructions, or else they will contaminate rather than sanitize the dishes. Utensils should be stored where they are free from flies, dirt, etc.

Single service containers such as straws and paper cups should be stored in a clean, dry place until used. Spoons and dippers used in dispensing frozen desserts should be kept in clean water; running water is preferable. Very often these dippers are forgotten except when being

used, and as a result *E. coli* has been found occasionally in water used to rinse these dippers.

Garbage must be stored in containers with tight-fitting lids, and should be hauled away daily. These containers should be scrubbed daily to keep them clean and free from odors. Sewage should be disposed of through the public sewer, or according to local health department rules if there is no public sewer.

Milk and milk products, preferably pasteurized, should be purchased from licensed companies. They should be dispensed in individual containers, or, if in bulk, according to the local health department rules. Milk and other perishable foods such as meats, custards, etc., should be refrigerated below 45° F. Drinking water should not be below 48° F.

Proper refrigeration is very important since it often is the only protection against food poisoning. Food that is stored prior to use should be kept in clean places free from flies, dust, and vermin. Rodent-proofing is likewise very important. It is imperative that the cafeteria, as well as the rest of the plant, be rodent-proof. It goes without saying that food contaminated by rats is not fit for human consumption. Consequently, there should be no laxity in a rodent-elimination program. The control of insects such as flies and cockroaches is imperative. Keeping food out of reach of insects as well as rodents will go a long way toward elimination of those pests. Screening and the cautious use of insecticides should simplify the problem.

Employees should wear clean uniforms and should keep their hands clean. Many times, clean uniforms create in the mind of the employee a greater sense of cleanliness, thereby helping to keep the rest of the cafeteria cleaner. Cafeterias, whether operated by the company or as a concession, should be responsible to the plant sanitarian for sanitary conditions.

A periodic cafeteria clean-up program will probably be conducted either by cafeteria personnel or by an outside agency hired to come into the plant for that purpose. Frequency and details of such a program will depend upon conditions at each plant. A comprehensive weekly clean-up program is a good general recommendation.

Sanitation standards of lunch counters.—The operation of a small lunch counter serving only hot drinks, candies, etc., whether it be a permanent, semipermanent, or a temporary arrangement, may be exempt from a few of the foregoing requirements, although certain fundamental requirements are necessary. The area must be clean, and food, drink, and the

utensils must be kept free from contamination. There must be a potable water supply. Utensils must be adequately washed in hot water with a satisfactory detergent and rinsed with hot, clean water of 180° F., or a residual chlorine of 50 p.p.m.

Eating of lunches should be permitted only in certain prescribed areas, so that the control of rodents and flies and the general clean-up program are not unduly complicated by indiscriminate scattering of lunch scraps. In some states eating of lunches in the same room where food is prepared is prohibited by law. Refuse cans should be distributed in convenient areas where leftover lunches and waste paper can be discarded and covered. Every effort should be made to get the employees to use these containers.

Adequate toilet and hand-washing facilities must be available. Requirements with respect to refrigeration and garbage disposal, and those which guard against the spread of communicable diseases, are naturally the same as for cafeterias. If vending machines are installed, local and state laws affecting their installation and operation should be studied. Sanitation standards of the plant in which the product was manufactured, processed, and stored prior to delivery should also be studied. Precautions against sale of stale products should be taken.

In addition to eating facilities in the plant, the well-known "greasy spoon" across the street may be a potential problem. In such instances, it is suggested that the local health department be made aware of the problem.

Physical examinations of food handlers.—Some state laws require that all food handlers serving the public have certificates indicating that they are free from communicable diseases. Preplacement physical examinations may be of value in picking up personnel with certain communicable diseases such as tuberculosis, venereal disease, etc. However, experience with these health certificates has been unsatisfactory for four reasons: First, one examination giving negative results does not necessarily mean that the handler is free from disease. Second, if the test is negative, granting a certificate does not take into consideration that the food handler may become infected the following day. Third, it creates in the minds of the public a sense of false security. Fourth, the cost would be too high and the examination too detailed and time-consuming if it were to determine the existence of all dangerous diseases communicable by food handlers.

Consequently, a well-rounded program of sanitation in the cafeterias,

including an educational program for the food handlers, seems to be the least expensive and the most efficient means of maintaining high standards of food sanitation.

Housing

Sanitary housing programs have as their broad aim the promotion of physical, mental, and social health. The accomplishment of this aim by any agency or organization, including private companies, will invariably be reflected in an economic saving through the efficiency, productivity, and availability of the individuals thus housed, plus an increase in the quality of the product produced.

Correction of insanitary housing in the past has been chiefly sporadic and isolated in application and ordinarily attempted through legislation and enforcement. While such measures are useful if administered intelligently, their practical application is dependent upon public coöperation and understanding of the desirability of such measures. When this understanding is widespread, the need for legislation and enforcement will not be present. The desirability of sanitary housing has been ably demonstrated by the various service organizations and others during the war period, and the worth of sanitation is being realized more definitely by such groups as public health organizations, the medical profession, large companies, etc. Sanitation of housing, working conditions or anything else, is preventive in nature and is generally accepted to be preferable to remedial measures after an insanitary situation is found to be causing difficulty.

Factors determining type of housing.—It is not possible to state a given set of recommendations for a type of housing to be used which will be sanitary and healthful in all situations. This problem, like most others, is individual and dependent upon several factors, including: first, the length of time the houses are to be used; second, frequency of moving; third, climatic conditions; fourth, whether rural or city sanitary accommodations are available; fifth, cost, and availability of materials. If units are to be moved frequently, tents or knockdown houses would be the types suggested. If climatic conditions are extreme, the unit would probably require materials with insulating qualities, etc. It must also be remembered that various federal, state, county, and city regulations may be available for assistance in determining the type of housing to install. It may also be necessary to comply with various laws and regulations.

Location and layout.—The location chosen for housing units is highly important to sanitation. If possible, a location on sandy or porous soil

should be chosen since it will assist in overcoming drainage difficulties and will maintain the understructure moisture at a minimum. If a porous soil location is not available, the area must be drained of surface water at least. In this regard, watershed drains (gullies, etc.) should be avoided because of the possible heavy water drainage during the rainy season. Low areas that are difficult to drain should also be avoided because of the accumulation and standing of rain water.

Housing locations must always be remote from any type of waste accumulations such as city or company dumps, and from swamps or other mosquito-breeding areas. Dumping grounds are invariably a fertile source of rodent and insect infestations. Unless excessive heat makes shade desirable, the buildings should be in the open rather than in dense growths of trees or shrubs.

The layout should be one that will permit a practical house-numbering system and that will make servicing of individual buildings easy. Arranging in rows, for instance, will facilitate the collections of garbage and refuse and will lessen the possibility of neglect at certain collection points. Feeding facilities should be removed from the quarters area and from the toilet facilities. This will assist in preventing the movement of flies from the waste materials to the food or living spaces. If livestock of any kind are in the vicinity, they should be removed at least 200 yards from all structures other than their barns.

Construction

A. *Temporary.*—Often, tents are used as a means of temporary housing, and with a little forethought can be made quite sanitary and healthful under temperate climatic conditions. A tent installation should always include a platform and frame with screening at doors and windows or other openings to exclude insect pests. The platform must be elevated above the ground level and secured soundly to the ground. This reduces rodent harborage and excessive moisture under the platform, and will withstand reasonably heavy winds. The tenting itself should be waterproof and have an over-all fly. Provision for roll-up sides and a ventilating opening with metal covering at the top will give satisfactory ventilation. Adequate heating and lighting of each tent is necessary.

Trailers may be used as temporary housing units. The sanitation of trailers and trailer camps presents a special problem chiefly because the sanitary necessities are individualized with each trailer. The sani-

tary structural features of bunkhouses such as smooth-fitting floors, walls, and joints are applicable to trailers. Other sanitary considerations such as waste disposal, water, food supply, etc., recommended for tourist camps are applicable to trailers.

Suggestions for Quonset huts and knockdown houses would include a combination of the features of temporary and permanent structures.

B. *Permanent.*—Permanent structures may include many different types of buildings such as quarters, galleys, and messhalls, bathhouses and washrooms, toilets, laundry and drying rooms, first-aid building, recreational building, garbage houses or platforms.

Several features of sanitary construction are applicable to all these buildings. Adequate lighting, heating, and ventilating are necessary in all. Tight, smooth-fitting floors and walls and smooth-fitting joints between walls, ceilings, and floors are desirable. Painted, smooth interior surfaces facilitate routine cleaning procedures. Screening on all possible openings is useful in excluding insect pests. Doors should have self-closing devices. In hot climates roof ventilation and reflective paints on the exterior will aid in keeping the buildings cooler. Where extremes of temperature occur, the use of various insulating wallboards, ceilings, etc., is indicated. Metal bedsteads and lockers are preferable to those of wood construction because the metal types are not as likely to harbor insect pests and because cleaning them is easier.

Wherever water is used continually, as in shower rooms, washrooms, and laundry rooms, the floors and at least the lower ends of the walls should be of material impervious to water.

Different buildings will need various types and numbers of sanitary fixtures such as toilet seats, urinals, washbasins, and showers. Hot and cold running water must be provided at least in the galleys, toilets, and wash and shower rooms.

The reduction of offensive odors is of especial importance in toilet buildings. The solution to this problem varies with the type of toilet, but it can be said that the separation of urine from fecal material will aid in the reduction of odors. Where ordinary water flush-type fixtures are used, this is not necessary.

Sanitary garbage-disposal houses or platforms should be provided. Some sanitarians prefer a simple elevated cement platform upon which covered garbage cans are placed, and others prefer an elevated cement platform with a screened house to protect the cans from

insects and rodents. Both of these types need constant supervision if they are to be operated efficiently, and both should be equipped for cleaning of platforms and cans, preferably with steam hoses, or at least with cold water hoses and brushes.

Pest Control—Insect and Rodent

The prerequisites for efficient, economical pest control are proper construction and sanitation. The pest problems within structures have been greatly reduced if not entirely prevented where these two factors have been properly followed through. The careful planning of construction with pest exclusion in mind, followed by general sanitary practices, will deny food and harborage to pests, making it impossible for them to invade and survive within a structure.

Other means of pest control are supplementary and should only augment, not replace, proper sanitary construction and practice. These supplementary measures include the use of insecticides and rodenticides, and the enlistment of coöperation from official or private organizations responsible for the sanitation of properties adjacent to the housing installation in mind.

Maintenance and Servicing

Regardless of the sanitary efficiency of the original structures and practices, their benefits will be of short duration unless they are maintained. Frequent routine inspections of construction details and of pest infestations should be made by the individual responsible for sanitation, and should be followed promptly by any necessary corrective measures.

Servicing should be assigned to a responsible janitorial force which is instructed in its sanitary duties and the importance of the service. Daily collection of garbage, paper, and refuse of any sort is desirable.

Farm Labor

Some food-processing companies operate their own farms, and the consequent responsibility for farm labor presents special sanitary problems to those companies.

Where farm labor is company-paid, it is the responsibility of the company to provide safe potable drinking water to the laborers. Farm crews should also be equipped with portable, sanitary privies.

Fish-processing companies which operate their own fishing boats should have sanitary water, food, and toilet facilities aboard the boats.

Chapter X

LABORATORY AIDS, SAMPLING TECHNIQUES, AND INTERPRETATION

A NUMBER of available laboratory tests may be of assistance to the sanitarian in the performance of his duties. It must be remembered that these should complement rather than substitute for visual observations and common sense. Each is briefly described below, with a statement of its use, and reference to the source in standard texts wherein the details of the method may be found.

SAMPLING

It must be remembered that no test can be better than the sample. This means that the sample must be representative, ample in quantity, and qualitatively suitable. In the collection of a representative sample, the following must be taken into consideration:

1. The character of the laboratory examination to be made.
2. The use to be made of the results of the analysis.
3. The character of the material sampled and the variation in the character over the period of sampling.
4. The variation in the rate of flow over the period of sampling.

A. *Bacteriological sampling*

1. Sterile equipment must be used; equipment varies with each test to be made.
2. Time and place of sampling. This is particularly important where studies are made of build-up on processing equipment.
3. Storage and shipment of sample. There is a maximum time and temperature limit on samples that are to be sent out for analysis.
4. Size of sample. This depends on the test or tests to be made.

B. *Chemical sampling*

1. Use only chemically clean equipment.
2. Sample of sufficient size to make all tests necessary. The various requirements for each test, as to technique, container, and size of sample, etc., are listed in the procedures for these tests.
3. Temperature during period of holding before test is made may be important in some cases.

TESTS AVAILABLE AND THEIR USE

A. *Bacteriological tests*

1. Total plate count. This gives a count of all living bacteria which will grow on the medium used. It is an indication of the total amount of contamination present, and does not differentiate between the different kinds of bacteria present. This test is useful in the following:
   a. Water supply. Should be checked at least twice each year, to determine the total contamination of the incoming water.
   b. Equipment. Can be used to check efficiency of clean-up and also build-up on equipment during operation.
   c. Product. For checking preprocessing contamination of canned foods, and for final count on frozen and dehydrated foods. The storage life after thawing or rehydration is directly proportional to the bacterial load.

   (Procedure for this test may be found in Refs. Nos. 1, 2, or 3, at the end of this chapter. Additional information may be found in Ref. No. 9.)
2. *Coli-Aerogenes* group test. This group of bacteria is an indication of fecal pollution. The specific technique of obtaining a water sample is detailed in chapter iii. A 4-oz. sample is usually sufficient. This test can be used on the following:
   a. Water supply. All water on the product or for drinking or handwashing must meet the requirements of the U. S. Public Health Service for water on public carriers.
   b. Product. Organisms should be absent. Presence of these organisms indicates improper washing of product, or contamination from workers or water supply.
   c. Workers. Organisms should be absent from hands. Presence indicates lack of personal hygiene of the workers.

   (Procedure for this test may be found in Refs. Nos. 1, 2, or 3. Additional information on this test may be found in Ref. No. 9.)
3. Direct count. This is a quick method for estimating the total number of living and dead microörganisms in water supply or product. This method is not very accurate or reliable.

   (Procedure for this test may be found in Refs. Nos. 1, 2, or 3.)
4. Biochemical oxygen demand (B.O.D.). B.O.D. is the amount of oxygen in parts per million required by water, sewage, or industrial

wastes during stabilization of the decomposable organic matter by aerobic bacterial action. This test is useful in determining the efficiency of sewage treatment or dilution of the sewage.

(Procedure for this test may be found in Refs. Nos. 2 or 3. Additional information on this test may be found in Ref. No. 8 and also in most books dealing with waste disposal.)

B. *Chemical tests*

1. Mineral salts or hardness tests. These are made on water for determining the proper kind and amount of detergents suitable for use with that particular water; also to determine the potability of the water and desirability of it for processing use as far as it is governed by chemical content. One gallon of the water is usually sufficient for the tests.

   (Procedure for these tests may be found in Refs. Nos. 2 or 3. Additional information may be found in Ref. No. 9.)

2. Residual chlorine test. The usual method is the orthotolidine test. This is not suitable in the presence of certain impurities as described in the procedure. It is used:
   a. To check water supply after chlorination.
   b. To check concentration of sterilizing solution used in plant.

   (Procedure for these tests may be found in Refs. Nos. 2 or 3. Additional information in Refs. Nos. 4 and 9.)

3. Total solids determination. For determining efficiency of screening and settling operations on sewage.

   (Procedure may be found in Refs. Nos. 2, 3, or 4.)

4. pH measurements. For determining the degree of acidity or alkalinity; used in the control of water and sewage treatment processes, and on recirculated flume waters to indicate bacterial contamination.

   (Procedure may be found in Refs. Nos. 2 or 3.)

5. Urea test. Confirming test for the presence of rodent urine on materials or ingredients. A small piece of the suspected material is sufficient.

   (Simple method available from Federal Food and Drug Laboratory in Washington, D. C.)

6. Miscellaneous tests for metals and poisons. Can be used where there is a question of contamination from metals or poisons that may have entered into the food.

   (Procedures may be found in Refs. Nos. 4, 5, and 6.)

C. *Physical tests*

1. Fluorescence. Ultraviolet light of 3600 Å can be used for the detection of urine stains on materials. It must be remembered that other compounds also produce fluorescence and a confirmatory test for urine may be necessary. A suitable bulb can be obtained from the General Electric Company. This is designated as G.E. 250 A-21/60. More expensive and elaborate units can also be obtained from other companies.

D. *Interpretation of laboratory results*

It is seldom that the results of laboratory tests alone will solve problems in environmental sanitation. They must be correlated with field observations and interpreted by experienced field inspectors. Laboratory workers lacking field experience are not likely to be able to make valid interpretations of the results of tests. They are not usually cognizant of the many factors other than laboratory factors which bear upon sanitary problems.

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Chapter XI

INSPECTION TECHNIQUES

THE FUNDAMENTAL reasons for careful inspection of food-processing plants are: first, to determine the types and the extent of the sanitary problem; second, to gain factual data upon which to base the outline of a sanitary program; third, to evaluate progress of the program; and fourth, to check its routine operation.

The sanitary survey constitutes the first step. It is at once the most comprehensive and the most detailed because it must include, for example, a thorough inspection of the surrounding area with reference to its effect on sanitary control in the plant; also to be evaluated is the adequacy of lighting, ventilation, and temperature control. But it must include, of course, the close check of every detail of plant machinery and equipment. The sanitary survey might be outlined in the following manner. This will not be applicable in every case, but is designed only to show the more important features.

A. Where and how to look
   1. Use flashlight to inspect out-of-the-way places.
   2. Sight. Most exterior dirt and filth can be seen with the eye.
   3. Smell. Places that are overlooked soon give themselves away by the odor that arises.
   4. Feel. Slime and filth can be felt in places that are hidden from the eye.
   5. Decayed material gives itself away by the presence of fruit or vinegar flies.
   6. Bacterial growths can be uncovered by routine bacteria counts on product and equipment.

B. General surroundings of the plant
   1. Does location present problems affecting sanitation of the plant? Are any animals housed near by?
   2. Are there rodent harborages which will feed rats into the plant? Are prevailing winds going to bring in flies, dust, and smoke from neighboring areas? Will soot from railroad locomotives drift into plant?
   3. Is drainage of surface water directed away from the plant, or is adequate provision made for peak runoff?
   4. Does the box pile offer rodent harborage? Are the boxes contaminated with soot from passing trains?

C. Construction and over-all layout of the buildings
   1. Will walls and roof keep out the elements and prevent the entrance of wind-blown dust and debris where they might contaminate food?
   2. Is construction such that it can be kept reasonably clean? Do overhead rafters offer runways for rats and mice?
   3. Does overhead piping "sweat" and the condensate drip onto workers or into food in preparation?
   4. Could building be, or is it, ratproofed and does it exclude insects and flies?
   5. Is the over-all layout of the plant planned so that raw material will not have to be conveyed through or stored in preparation rooms?
   6. Does dust from box dumpers or produce washers sift through to canning or packaging tables?
   7. Is the flow of the product rapid and orderly or are there cross currents leading to collisions and confusion? Are there graders, conveyors, or catwalks passing over can lines, sorting belts, or any food in preparation?

D. Equipment and machinery
   1. The two basic factors in evaluating these are: (*a*) Does each machine do the job expected without contaminating the food product, and (*b*) Can it be kept in a sanitary condition without too great a labor cost? It is impossible to give directions for inspection of all types of food production machinery, but the following are common to most plants.
      a. *Box dumper:* Does it injure natural covering of product? Does it screen out any incoming clods of dirt, dust? Does dust sift into canning or packaging room?
      b. *Washers:* Do they remove all field soil and loose debris? All insects from surfaces? Is adhering rinse water clean? Can they be cleaned and kept clean?
      c. *Graders:* Are they clean underneath the sieves? How are the drip pans fastened? Can they be taken off to be cleaned?
      d. *Cutters:* Are knives shielded properly? How are the knives attached? Can they be cleaned without demounting?
      e. *Blanchers:* Are they made of material which can be cleaned? Do they have adequate heating to bring temperature up quickly and hold it during operation? In draper types is the belt properly constructed for ease in cleaning? Are the drive wheels kept free of crushed material?

f. *Holding tanks:* Check carefully for evidence of bacterial build-ups. Is there equipment available for thorough cleaning and sterilization?

g. *Sorting and conveying belts:* Is surface smooth? Are edges worn and frayed? Are mold and slime growing on belts? Check the drive wheels, the idlers and rollers under belts. Look for slime on channel slides and separators. Are channels of wood or rough metal? Are drip pans provided? How are they cleaned?

h. *Pipe lines:* Are they permanent or demountable? Sanitary fittings, or common thread type? Are valves opened and cleaned? Do the lines have dead ends, multiple taps? Do pumps have demountable plates which can be removed easily for cleaning? Are lines used for several products?

i. *Fillers:* Are bowls protected from overhead condensate? Are valves clean? Can they be removed for cleaning? Are salt dispensors clean and free from corrosion?

j. Other equipment.

E. Storage and warehousing

Perishables: Is temperature of storage area satisfactory? How long have contents been stored? Is there evidence of mold, rot, or heating in boxes? Are they protected from floor, and from rodent or insect contamination? Are boxes clean and in good repair?

Nonperishables: Are sacks of flour, starch, salt, and sugar protected from rats, moisture, or insects? How are spices and flavorings stored? Is area of raw material storage free from any evidence of rodent infestation? From any insect infestation? Are finished products stored with raw materials? Is warehouse used as storage space for odd machinery?

Finished product: How are cans stored? Are they protected from dust and moisture? From careless lift truck drivers? Are there aisles left for periodic inspection? Do pallets offer rodent harborage?

F. Water supply

Is source municipal or private? If private, is water known to be potable? Who checks? Is there a chlorination system? Who operates it? If dual supply, are there cross connections? Is supply adequate for peak loads? Is pressure maintained at all times? (30 lb. or above.)

Are there any fixtures which might allow back siphonage?

Is storage tank enclosed pressure type or tower tank? Is tower tank protected from birds or climbing rodents? Are algae controlled?

If wells are used for private supply, are they protected adequately from surface and underground contamination?

G. Sewer system and sewage disposal

1. Is sewer system separate from waste disposal? If not, what provision is made for possible stoppages? Could toilet sewage back up into plant?
2. Is sewage disposal into municipal or private system? Is private system adequate? What type? Is there any connection between floor drainage system and sewer system? Could toilet sewage back up into floor drains? Are all drains trapped to prevent entrance of sewer gases or rats into buildings? Is there any danger of overflow or leakage from upper floor toilets?

H. Waste disposal

Is there separation of liquid waste and solid materials? Is area used for separation kept rodent-free and are insects excluded or controlled? Is solid waste removed oftener than daily? How is it held until it is removed? Is waste material converted into a saleable product? Does this process present a hazard to sanitation of the plant proper? How is it separated?

I. Cafeteria

How does it smell? Are floors clean? Are tables in good repair? Is there sufficient seating capacity? Proper ventilation? Adequate lighting? How is food displayed? Is it protected from flies? Is there protection from respiratory contamination? Are cream-filled pastries kept cold? How are dishes and silverware washed and sanitized? Is dishwasher or sink made in three compartments? How are dishes dried or drained? Are they protected adequately after they are cleaned?

Are work tables, stoves, shelves reasonably clean and free from grease? Is there any roach or ant infestation? Or any sign of rodents?

Is refrigerator clean and fresh? Is temperature below 45° F.? How are food materials placed on shelves? Are pans resting on other pans of food? Are packages on upper shelves? Can food in refrigerator be contaminated by materials carried in from outside? Are food handlers trained in sanitary practices? Do they wear clean aprons and head dresses?

J. Sanitary facilities

Is odor objectionable? Is there outside ventilation? Are there adequate numbers of toilets, urinals? Is privacy sufficient? Are there

hand-washing facilities, hot and cold water, soap, individual towels? Are there hand-washing posters? Is floor clean, dry? Are walls clean and painted? Is mopboard watertight? Are there containers for towels?

K. Personal habits of employees

Do they appear to be aware that they are handling food products? Do they wear uniforms and headdress? Are uniforms clean? Do they wear rubber gloves? Is there any evidence of dermatosis on hands of food handlers? Do they wash their hands when leaving toilet? Who supervises? Did you observe any sputum on floors? Do they use tobacco while handling food?

L. Rodent and insect infestation

Is there any visual evidence of rodents? Look for droppings, runways, grease marks, burrows, nests, gnawed scraps of food, live or dead rats. Is your rodent control effective? Who checks? Are there flies, roaches, ants or other insects through the plant? Where are they coming from and where are they going? Look especially in the sirup room, cafeteria, receiving area, and the toilets. Are there breeding places inside or near the plant? Are there screens to keep insects out?

M. Lighting, ventilation, and temperature control

1. Look for dark corners. Measure the lighting over sorting and canning belts and packaging tables. Is there incorrect lighting, glare, or deep shadows?
2. Does inadequate ventilation result in excessive moisture and dripping condensate from coiling and overhead piping? Is there satisfactory removal of fumes of truck exhaust in all parts of the plant?
3. Is there insufficient or excessive heat and humidity for efficient and comfortable work? Are there drafts or points of excessive radiation?

N. Clean-up procedures

The evaluation of clean-up procedures is primarily a matter of inspection of the machinery and equipment of the plant. If the results are satisfactory, the procedures are probably adequate. Chapter iv on cleaning and disinfection discusses the criteria of cleanliness.

Chapter x offers laboratory tests for bacterial counts. The basic questions are: "Do the clean-up procedures leave the surfaces free of all material which would contaminate food products?" and "Are clean-ups frequent enough to prevent build-ups of serious sources of contamination?"

Many other items will suggest themselves in different plants and industries. These various headings are not taken in the order of their

relative importance, because each plant will find the order of urgency a matter of individual conditions. It is hoped, however, that the foregoing will be a reminder and an outline upon which to build a complete sanitary survey for each plant.

The second step in food-plant inspection is the daily round or checkup. The sanitary survey will point out the most serious problems of contamination. The most effective way of remedy is by constant inspection and discussion of progress or lack of progress with the person responsible. These inspections will have to be timed with the operations; for instance, the clean-up procedures will have to be evaluated during clean-up periods, while a survey of cafeteria conditions could best be done in early afternoon.

If the most serious sanitary problem is the direct contamination of food products in the preparation machinery, it is probable that for a time the sanitarian will find it necessary to supervise personally the cleaning of the machinery responsible. Methods recommended from the office are usually inadequately applied by untrained men. After proper methods have become habitual, inspection will be all that is required.

It may be that several urgent conditions will take up the entire day for the sanitarian until the most important ones can be cleared up. However, there are a few points of food industry sanitation which require daily attention:

First: Careful watch on incoming raw materials to be sure no excessive contamination or rot comes into the plant. In some plants this may be the responsibility of quality control. It is impossible to eliminate some overlapping of the sanitarian's work with other endeavors in the plant. If the sanitarian realizes this and approaches such a situation in a spirit of coöperation, no conflict of endeavor or authority should result.

Second: Make certain that all surfaces in direct contact with food products have been cleaned and disinfected in accordance with regular procedure.

Third: Be sure that no gross filth is getting into the product in any stage.

Fourth: Inspect toilets and washrooms.

Fifth: Check the cafeteria carefully.

Sixth: Watch for any laxity in general housekeeping.

The daily round of inspection is in itself a very important part of the sanitarian's job. The fact of his regular presence leads to a continued consciousness of a sanitary program among the employees.

While he is making his inspections, questions and observations by workers give the sanitarian many opportunities to instruct a receptive person in sanitary practices. Such conversations are often the most fruitful of all types of education. The sanitarian's success depends to a large degree on this education. Only if the majority of the workers are willing to coöperate can any plant be kept in truly sanitary condition.

The foremen of the various departments are usually eager to know that their efforts are being judged and that the chance to explain further ideas and practices is presented.

The sanitarian will find it necessary to take a special interest in the health and comfort of the workers as far as the organization of his plant requires. The friendship and coöperation of the Union Shop Stewards and Grievance Committee Chairman can be a valuable aid to the sanitarian. Many of the employee's "beefs" are of direct concern to him and it may be possible to solve these problems without difficulty and to everyone's satisfaction. This source of assistance should be used with the utmost caution because management is—in some cases—very suspicious of undue sympathy with complaints of grievance committees. However, if he has a sincere desire to help the employees to better health and efficiency, to teach them the essentials of hygienic decency, and to give his employer the full benefit of his knowledge and training, with tact and intelligence the sanitarian will find employee relationship satisfactory.

Chapter XII

THE PLANT-SANITATION PROGRAM

THE PURPOSE of this chapter is to outline the establishment of a sanitation program in a food-processing industry. To make the discussion apply to the largest possible number of situations, it is assumed that the management, the superintendents, and the foremen must be shown the necessity and scope of a sanitation program. The most difficult job of the sanitarian is to win their support and wholehearted coöperation. Their chief concern is production, and a sanitation program must be approached with the idea that production comes first. Let the management know that you have this in mind, and avoid being looked upon as a policeman.

The details for instructing personnel in sanitation work will be found in the preceding chapters of the manual. Here we attempt only to organize and outline the task of bringing sanitary practices to a food industry.

In organizing a sanitation program, no set formula can be given. In order to be successful it will have to be individualized to meet the requirements of the plant or plants that are to be incorporated into the program. However, there is a certain procedure that can be followed.

Sanitary survey.—A comprehensive survey is necessary that will cover all phases of plant sanitation. A survey form or check list can be prepared to avoid overlooking pertinent items. For details of a survey see chapter xi.

Written report.—When the survey is completed, prepare a written report in which all insanitary conditions are described. Those conditions that are related can be grouped together and the whole arranged according to their importance. Each point mentioned should be accompanied by suggestions on what you believe could be done to correct the condition. The top management alone should receive the report and should have ample time to study it before meeting with the sanitarian.

Discussion with management.—If the survey is the initial one for a plant, we believe it would be well to open the discussion with a brief summary and interpretation of the Federal and State Food and Drug Acts.

The economic reasons for maintaining a sanitary plant should also be emphasized.

It should be noted that the changes and proceedings necessary to

establish a sanitary plant cannot be fulfilled at one time or even within one year. As the report is discussed, those changes and improvements that are most imperative should be stressed and plans made for their speedy realization. It may be years before some of the recommendations can be adopted. Whenever major repairs or rearrangements of equipment in the plant are made, the sanitarian will find excellent opportunity to include his suggestions. If new equipment is to be purchased or constructed, the sanitarian should study the design to determine if the equipment can be cleaned readily and maintained in a sanitary condition. The plans for new buildings should be studied with a view to sanitary upkeep, rodent-proofing, ventilation, and lighting.

In any discussion with management the question of cost will be foremost. How much will it cost to make the changes you suggest? We believe the sanitarian should be prepared to give a fairly accurate estimate of the cost. This can best be arrived at through discussions with the engineer and cost accountant. At the same time, the sanitarian must be prepared to show that this outlay of money will bring good returns in the form of insurance against possible federal seizures, lower incidence of spoilage, better morale of the employee, etc.

The proposed expenditures for sanitation should be incorporated in the budget. If necessary, a separate account can be set up for all phases of the sanitation program.

Delegation of authority.—To maintain a sanitary plant, some one person must bear the responsibility and consequently have the authority to see that his orders are carried out. He should be responsible to the management, not to the control laboratory or a foreman. There are numerous situations that will arise:

1. A large plant with a full-time sanitarian.

What at first seems to be a small, specialized field will soon broaden by the addition of duties and the realization that the sanitarian can act as a coördinator in many phases of plant maintenance and personnel relations. This is the ideal sanitation setup, rare at the present time. As the field grows and develops, we feel that the industry will come to recognize the office of the sanitarian to be as necessary and important as the quality-control and research departments.

2. A group of plants under one trained sanitarian.

This will be a fairly common situation. In this case the sanitarian will have to choose a reliable person to carry out his orders and maintain sanitary conditions on a daily basis. The sanitarian will need to give this

assistant thorough training and to provide him with a dignified title and good wages.

3. A trained sanitarian who was originally hired as a quality-control man, a superintendent, a foreman, or in some other capacity, and is still expected to carry out these other duties:

Unfortunately this situation will be fairly common and gives rise to a very difficult problem. If there is a one-man quality-control department with a full schedule on control work, it is suggested that the responsible person be given an assistant to take care of some of the routine work and allow sufficient time for adequate attention to sanitation. There should be an equal division of effort between sanitation and quality control. Neither should suffer with respect to the other.

Organization of a cleaning program:

1. Make time studies and job analyses of all cleaning procedures.

2. Choice of personnel. It is very important that the personnel handling clean-up should be chosen as carefully as possible.The clean-up should not be used as a job for pensioners or men unfit for regular plant work. The work is strenuous and requires a lot of elbow grease. Much of the inefficiency of clean-up can be blamed on poor clean-up personnel, poor supervision, and improper training. The quality of the help should be equal to that used in any other phase of the industry. Good wages should be offered.

3. Choice of title for the cleaning operations should be considered carefully. For example, substitute custodian for janitor, sanitation crew for clean-up crew, etc.

4. Division of labor:

   a. The foreman is responsible for the clean-up of his area, and he in turn is checked on by the superintendent. This method has certain disadvantages. The superintendent will probably be unable to check the clean-up thoroughly and frequently enough to insure constant cleanliness. There are likely to be certain areas over which no foreman claims responsibility, and these will be overlooked. If there is a sanitarian in the plant, he can school the foreman on cleaning procedure and definitely define the areas to be cleaned.

   b. A separate clean-up crew. This is perhaps the best method of insuring efficient and intelligent cleansing of the plant. Because of their irregular working hours this crew should be given good wages, and perhaps bonuses to stimulate interest and efficiency.

The crew can be trained by the use of lectures, laboratory demonstrations, and plant demonstrations. They should be made sanitation-conscious. The cost of a special sanitation crew, small and efficient, will be much less than holding the whole production crew overtime to do their own clean-up.

5. Cleaning material. Labor-saving equipment and adequate detergents should be available and the crew well schooled in their use. See chapter iv.

Psychologists say that the chief motivation power of people is the desire for a feeling of personal worth and self-respect. If you can show the personnel that their work is of direct importance to the public, the management, and their fellow workers and that the importance of their part is recognized, you will accomplish more than by the use of threats and direct orders.

Follow-up survey.—When the sanitation program is under way, the job of the sanitarian is just well started. There are few jobs that take such vigilance and so much supervision. Follow-up surveys must be made to determine what progress has been made toward correction of conditions found in the original surveys. The day-by-day procedures must be checked and rechecked to avoid omissions, carelessness, and negligence, and to find where improvements can be made and further savings effected through increased efficiency of the methods, workers, and materials.

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